SCIENCE

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AUGUST WEISMANN[1]

AUGUST WEISMANN, a foreign member of this society, was born at Frankfort on the Main, January 17, 1834, and died at Freiburg in Breisgau, November 6, 1914. He early showed the traits of a naturalist and in one of his books speaks of the excitement he felt as a boy in catching butterflies. He attended the University of Göttingen, where he studied chemistry and medicine, coming especially under the instruction of the distinguished anatomist Henle, and receiving the degree of M.D. in 1856. After spending three years at Rostock as an assistant he began the practise of medicine at Frankfort and during this time he visited Vienna in 1858, Italy in 1859 and Paris in 1860. From 1861 to 1862 he was private physician to Archduke Stephan of Austria at Schamburg Palace. He then studied zoology at Giessen under the renowned zoologist Leuckart and became privat-docent in zoology at the University of Freiburg in 1863, where he spent the remainder of his life. In 1866 he was appointed professor extraordinarius and a few years later became professor ordinarius, which position he continued to hold until a few years before his death, when he was made professor emeritus.

In person he was a man of striking appearance, being about six feet tall and well proportioned and having a fine head and face and an earnest but kind expression of the eyes. From 1864 to 1874 and again from 1884 on he suffered from an eye trouble which interfered greatly with his

[1] Read before the American Philosophical Society, January 1, 1915.

microscopical work and turned his attention to theoretical questions. One of his former students and assistants, Professor Alexander Petrunkewitch,[2] to whom I am indebted for much valuable information concerning his personality, says that although he was usually quiet in manner, he invariably became nervous and unhappy in the presence of moving objects, which painfully affected his eyes.

A short autobiography published in *Lamp* in 1903 gives a glimpse of his family life:

> During the ten years (1864–74) of enforced inactivity and rest occurred my marriage to Fräulein Marie Gruber, who became the mother of my children and was my true companion for twenty years until her death. Of her now I think only with love and gratitude. She was the one who more than any one else helped me through the gloom of this period. She read much to me at this time, for she read aloud excellently, and she not only took an interest in my theoretical and experimental work, but she also gave practical assistance in it.[3]

His great work on the "Natural History of the Daphnoidea" (1876–79) is dedicated to "My father-in-law, Adolph Gruber, in thankful memory of the beautiful hours of leisure spent on the shores of Bodensee." His colleague, the anatomist Wiedersheim, married another daughter of Gruber who was a Genoese banker. After the death of his first wife Weismann married again when abouty sixty years old, but not happily. One of his daughters married the zoologist W. N. Parker, who translated into English his best-known work "The Germ Plasm." A son was trained as a professional violinist.

Weismann, like so many other naturalists, was of an artistic disposition. He loved nature, art and music and he was an accomplished pianist. During the periods when he suffered much from his eye trouble he says that he "found solace in playing a good deal of music." He was an enthusiastic admirer of Beethoven, but could not appreciate Wagner. His artistic temperament is further shown in many of his essays, which for beauty of expression are rarely surpassed in scientific literature.

He was an excellent speaker, being simple and earnest in manner and never indulging in jokes. His lectures on evolution, which were delivered regularly for almost forty years, were famous and always attracted great audiences. As a teacher of advanced students he was stimulating and helpful, a kind critic and an attentive listener.

He took no active part in politics, but, like many German professors, was a member of the "National Liberal" party. In philosophy he held tenaciously to a mechanistic conception of nature, but he believed that extreme mechanism was consistent with extreme teleology; indeed, he held that

> The most complete mechanism conceivable is likewise the most complete teleology conceivable. With this conception vanish all apprehensions that the new views of evolution would cause man to lose the best that he possesses—morality and purely human culture.

In his philosophy as in his scientific controversies he was extremely tolerant. He was interested in the promotion of knowledge, but was not aggressive nor offensive in manner.

Inasmuch as his life was so largely given to the extension and support of the Darwinian theory, it is interesting to hear from himself how that theory first came to his attention. After remarking, "I never heard evolution referred to in my student days," he describes the influence on himself of Darwin's book in these words:

> I myself was at the time in the stage of metamorphosis from a physician to a zoologist, and as

[2] I am also indebted to Professor H. H. Wilder, of Smith College, and to Professor J. S. Kingsley, of the University of Illinois, for information regarding the family life and personality of Weismann.

[3] Quoted from Locy's "Biology and its Makers," p. 401.

far as philosophical views of nature were concerned I was a blank sheet of paper, a *tabula rasa.* I read the book ["Origin of Species"] first in 1861 at a single sitting (*sic*) and with ever-growing enthusiasm. When I had finished I stood firm on the basis of the evolution theory, and I have never seen reason to forsake it.

With just pride he mentions the fact that he was one of the first scientific men in Germany to defend publicly Darwin's theory; Fritz Müller was the first to publish a work in favor of that theory ("Für Darwin," 1864), Haeckel was the second ("Generelle Morphologie," 1866) and Weismann was the third, his inaugural address at Freiburg on the "Justification of the Darwinian Theory" ("Ueber die Berechtigung der Darwin'schen Theorie") being published in 1868.

Thereafter his contributions to the Darwinian theory were numerous and important. They appeared from 1872 to 1902 as a series of books and contributions. Five of these earlier contributions were translated into English by R. Meldola and were published as two large volumes in 1882, with an introduction by Charles Darwin. Subsequent studies on evolution were so intimately associated with his theories of heredity that they can best be considered under that topic.

Weismann's contributions to biological theory were so extensive and important that they overshadow to a great extent his observational and experimental work, and yet the latter was by no means small or unimportant. Among these observational and experimental studies must be mentioned especially his extensive works on "The Development of Diptera" (1865), "Natural History of the Daphnoidea" (1876–79), "Origin of the Sex Cells of the Hydromedusæ" (1883), "Seasonal Dimorphism of Butterflies" (1875), "Origin of Markings of Caterpillars" (1876) and "Transformation of the Mexican Axolotl into *Amblystoma.*"

Some of his earlier work was done without assistance, but in all of his later observational and experimental studies he had the assistance of his wife or other helpers. Much of his work was done in collaboration with some of his students or assistants. His method of work was to a large extent forced upon him by his eye affliction. After 1864 all reading had to be done for him, at first by his wife and after her death by a secretary. Experimental work was done under his supervision by his assistant and janitor. All microscopic work was done by his pupils, to whom he suggested topics and whose work he supervised daily. These theses were always in direct relation to his theories and to that phase of them which interested him most at the moment.

But valuable as much of his observational and experimental work was, there is no doubt that he will be remembered chiefly for his theories of heredity. His earliest writings on this subject date from the year 1883 and his latest were published but a few years before his death. His "Essays upon Heredity and Kindred Biological Topics" were translated into English and published in two volumes in 1889 and 1892. Probably his most important work on this subject is his book entitled "The Germ-Plasm, A Theory of Heredity" which was published in English in 1893. Subsequent works on heredity are "On Germinal Selection" (1896) and "Vorträge über Descendenztheorie" (1902). This last-named work, which was published in English under the title "The Evolution Theory" (1904), consists of a summary and an expansion of many of his previous writings on the subjects of evolution and heredity; indeed, as he says in the preface of this book, it is "a mirror of the course of my own intellectual evolution."

Without attempting to analyze these different books, which would require more time and space than is here available, we may proceed at once to a summary of his more important contributions to the theories of evolution and heredity.

All his theories, of both heredity and evolution, center in what he called the "germ-plasm," that particular part of the germ-cells which serves to carry over from generation to generation the inheritance factors. This germ-plasm was held by Weismann to be absolutely *continuous* from the present generation back to the earliest generations of living things; it was absolutely *distinct* from the somatoplasm of the body and the latter could never become germ-plasm; it was almost perfectly *stable,* undergoing practically no changes except such as came from the mixing of different kinds of germ-plasm (amphimixis) in sexual reproduction.

These views as to the nature of the germ-plasm underwent some modification as the result of criticism. Weismann was forced to admit that the distinctness and stability of the germ plasm were not absolute, but in spite of all criticism he was able to maintain that the germ-plasm was relatively very distinct from other plasms and very stable in organization, and this is now admitted by all persons acquainted with the subject.

His views as to the separateness of somatoplasm and germ-plasm, of body cells and germ cells, and the mortality of the former and potential immortality of the latter, led him to regard organisms in which this distinction does not exist (many protozoa and protophyta) as potentially immortal. With a keenness of insight which was not appreciated at the time, but which has been confirmed by recent work, he reasoned that "conjugation like food and oxygen may be conditions of life, but immortality does not rest on the magic of conjugation any more than on food or oxygen." Again he anticipated the most recent opinions when he held that death is not a necessary correlative of life, but rather the result of higher differentiation. In short, as Minot said, "Death is the price we pay for our differentiation." On the other hand, his attempt to explain the origin of death as a direct adaptation due to selection was probably a mistaken one.

As to the location of the germ-plasm in the sex cells Weismann maintained that it was to be found in the chromatic substance of the nucleus. He held that the chromosomes ("idants") were composed of smaller units, the chromomeres ("ids"), and that the latter were composed of "determinants" or inheritance units, while the most elementary units of life he called "biophores." Both chromosomes and chromomeres are visible structures of the cell. Determinants and biophores are ultramicroscopic in size, but recent work on heredity and development has shown that there is good evidence of the existence of such units. All recent work in genetics is based upon the hypothesis that there are units or factors or determiners in germ cells which condition the development of adult characters, and though there may be minor differences between these *determiners* of modern genetics and the *determinants* of Weismann, no one can fail to note the genetic connection and the family resemblance between the two.

His prediction on purely *a priori* grounds that one of the maturation divisions in the formation of the egg and sperm should be a "reduction division" whereby the chromosomes of the sex cells should be reduced to half the number present in the somatic cells, whereas all other cell divisions should be "equation divisions" in which the chromosomes should divide equally, was almost as brilliant an example of scientific

prophecy as was the prediction of the existence of the planet Neptune.

Similarly Weismann's assumption that the determinants are arranged in a linear series in the chromosomes finds strong support in the newest and most striking discoveries in this field, in which Morgan is able to locate at different points along the length of a chromosome the determiners of many developed characters.

Finally there is at present universal agreement to the declaration of Weismann that no purely epigenetic theory of heredity is possible, though for many years even this was hotly contested. When one recalls the storm of opposition which was called forth by his book on "The Germ-Plasm" the present acceptance, at least in principle, of his major propositions can not be viewed in any other light than as a triumph for his theory and a tribute to the insight, foresight and constructive ability of Weismann.

As a result of his theory of heredity Weismann was led to investigate the generally accepted doctrine of the inheritance of acquired characters. He carried on extensive experiments in order to learn whether mutilations of parents through many generations were ever inherited by offspring; he investigated many supposed cases of the inheritance of such characters, and as a result of this work he was led to deny altogether the possibility of the inheritance of acquired characters, and he challenged the world to furnish any satisfactory proof of such inheritance. This work of Weismann's called forth a tremendous amount of discussion and a relatively small amount of direct observation and experiment, and for several years it appeared as if no progress whatever was being made toward the solution of this great question, so full of importance, not merely for the biologist, but also for the practical breeder and indeed for the human race. But gradually there has grown up a clearer understanding of the problem and of what is meant by "inherited" and "acquired" characters, and gradually this dead-lock of opinions is breaking up. Now we recognize that inherited characters are those whose distinctive or differential causes are in the germ cells, while acquired characters are those whose differential causes are environmental. No one to-day believes that the developed or somatic characters of an organism are transmitted to the next generation. To-day the problem of the inheritance of acquired characters is merely this: Can changes in the environment change the constitution of the germ-plasm so as to produce changes in subsequent generations? No one now asks whether changes in developed characters may be transmitted to descendants, as was generally done before Weismann's work, for it is generally recognized that somatic characters, whether inherited or acquired, are not transmitted from generation to generation, the only thing which is transmitted being the germ-plasm. Weismann admitted in his later writings that the germ-plasm might be modified to a limited extent by certain environmental conditions, but he held that such changes of the germ-plasm led to general and unpredictable changes in future generations which might be wholly different from those somatic changes in the parents which were directly produced by such environment. This view is now widely accepted.

Thus while Weismann's views on this subject underwent certain changes in the course of his long life, the opinions of his opponents have undergone so much greater and more important changes that it may be truly said that in the matter of the inheritance or non-inheritance of acquired characters the greater portion of the scientific world has come to Weismann's position.

Finally, mention must be made of Weismann's theory of evolution which was a direct outgrowth of his theory of heredity. He maintained that evolution must depend upon an evolution of the germ plasm and that this was brought about chiefly, if not entirely, by the mixture of different kinds of germ-plasms (amphimixis) in the union of the sex cells. There is no doubt that many variations are produced by amphimixis, but in general these combinations of germ-plasms are not actual fusions; new combinations of inheritance units are produced, but not new units, and usually these new combinations split up in subsequent generations according to Mendelian rules, so that such temporary combinations of different germ-plasms do not usually lead to permanent modification, or to evolution, of the germ-plasm. On the other hand, it is probable that Weismann underestimated the possible influence of environment in producing changes in the germ-plasm and hence its influence on evolution; at least it does not seem possible at present to explain the origin of many inherited mutations except by the influence of changed environment upon the developing germ cells.

In his belief in natural selection Weismann out-Darwined Darwin or any of the Darwinians. Darwin dealt only with the survival of individuals or races in the struggle for existence and was always inclined to assign a good deal of weight to the influence of environment in producing new races. Weismann would not admit the existence of any other factor of evolution than selection and he extended this principle from individuals or persons ("personal selection") to organs and tissues ("histonal selection") and even to germinal units such as determinants and biophores ("germinal selection"). By means of an assumed struggle for nutriment between different determinants he believed that the weaker ones would tend to grow still weaker and to disappear, while the stronger ones would increase in strength until they reached such importance that they were checked, or increased, by personal selection. And by a similar struggle between different biophores he showed that the *quality* of a determinant would be changed. By means of this highly ingenious but purely formal and hypothetical system he was able to explain the degeneration and disappearance of useless parts of an organism and the concordant modification of many different parts in the course of evolution.

Of all his theories those which grew out of his belief in the "Omnipotence of Selection" have found least confirmation in subsequent work. The mutation theory of de Vries has come in to modify in certain important respects the theory of Darwin, and the work of Johannsen, Jennings, Pearl and others has shown that even "personal selection" has little or no influence in *creating* new types. And yet we have not seen the end of the selection doctrine. The elimination of the unfit is still the only natural means of accounting for fitness in organisms, and we may well ponder these words of Weismann in the preface of his last book:

> Although I may have erred in many single questions which the future will have to determine, in the foundation of my ideas I have certainly not erred. The selection principle controls in fact all categories of life units. It does not create the primary variations, but it does determine the paths of development which these follow from beginning to end, and therewith all differentiations, all advances of organization, and finally the general course of development of organisms on our earth, for everything in the living world rests on adaptation.

Clear thinking is necessary in the advance of science as well as fine technique, and Weismann has demonstrated to a more or less scornful world the importance of

brains as well as of hands and eyes in the discovery of truth. It does not fall to the lot of any man to make no mistakes, and in this respect Weismann was only human. But it has fallen to the lot of few men to do so much work of lasting value and to have so profound an influence on his day and generation as was true of August Weismann. The spirit of his life and work may be summed up in the beautiful words with which he closes his essay on "Life and Death":

> After all it is the quest after perfect truth, not its possession, that falls to our lot, that gladdens us, fills up the measure of our life, nay! hallows it.

EDWIN G. CONKLIN

PRINCETON UNIVERSITY,
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THE PLACE OF WISDOM IN THE STATE AND IN EDUCATION[1]

> So soon as men get to discuss the importance of a thing, they do infallibly set about arranging it, facilitating it, forwarding it, and rest not till in some approximate degree they have accomplished it.—CARLYLE.

THIS, doubtless, is a true statement; the difficulty is, however, to persuade men of the importance of a thing. We come to persuade you. As an association we are now eighty-four years old: our main purpose has been to obtain a more general attention to the objects of science and a removal of any disadvantages of a public kind which impede its progress—let me also add, its application to culture and to the public service.

By holding meetings, year after year, in the principal towns of the British Isles, the association has at least brought under notice the fact that science is a reality, in so far as this can be testified to by several hundreds of its votaries meeting together each year to consider seriously and discuss the progress of the various departments. On the whole, dilettanti have had little share in our debates. The association has already carried the flag of knowledge outside our islands, thrice to Canada and once to South Africa; now, at last, we make this great pilgrimage to your Australian shores; still we are at home. What message do we bring with us?

In 1847, when this city was but an insignificant town, it was visited by an Englishman who afterwards became eminent not only in science, but also as a literary man—Thomas Henry Huxley; he was then surgeon on board the surveying-ship *Rattlesnake*. In 1848 Huxley visited Sydney, and there met the gracious lady, only recently deceased, who became his wife. In after years he achieved a great reputation on account of his services to education.

Lecturing in London in 1854, he defined science as "trained and organized common sense"—a definition often quoted since; none could be more apposite, though it must be remembered that "common sense," after all, is but an uncommon sense.

A few years later, in a public lecture at South Kensington, Huxley spoke to the following effect:

> The whole of modern thought is steeped in science; it has made its way into the works of our best poets and even the mere man of letters, who affects to ignore and despise science, is unconsciously impregnated with her spirit and indebted for his best products to her methods. I believe that the greatest intellectual revolution mankind has yet seen is now slowly taking place by her agency. She is teaching the world that the ultimate court of appeal is observation and experiment and not authority; she is teaching it the value of evidence; she is creating a firm and living faith in the existence of immutable moral and physical laws, perfect obedience to which is the highest possible aim of an intelligent being.
>
> But of all this your old stereotyped system of education takes no note. Physical science, its methods, its problems and its difficulties, will meet

[1] From an address to the Educational Science Section of the British Association at Melbourne, by Professor Henry E. Armstrong, F.R.S., The Central Technical College, London.

the poorest boy at every turn, and yet we educate him in such a manner that he shall enter the world as ignorant of the existence of the methods and facts of science as the day he was born. The modern world is full of artillery: and we turn our children out to do battle in it equipped with the shield and sword of an ancient gladiator.

Posterity will cry shame on us if we do not remedy this deplorable state of things. Nay, if we live twenty years longer, our own consciences will cry shame on us.

These words were uttered in 1861. Now, after more than fifty years, not twenty, merely, we still go naked and unashamed of our ignorance: seemingly, there is no conscience within us to cry shame on us. I have no hesitation in saying that, at home, at all events, whatever your state here may be, we have done but little through education to remedy the condition of public ignorance which Huxley deplored. In point of fact, he altogether underrated the power of the forces of ignorance and indifference; he failed to foresee that these were likely to grow rather than to fall into abeyance. In England, what I will venture to term the Oxford spirit still reigns supreme—the spirit of the literary class—the medieval spirit of obscurantism, which favors a backward rather than a forward outlook.

Wherein was Huxley out in his forecast? In 1861 the claim of science was already strong, but think what has been done since that time—what we can now assert of its conquests! In the interval, even within my recollection, the whole of our ironclad fleet has been created, rifled cannon, smokeless powder and dynamite have been introduced, and this last, in combination with the discovery of the causes of yellow fever and malaria, has made the Panama Canal possible, an entirely revolutionary work of man's interfering hands. The *Great Eastern,* which could not be launched at first on account of her size—as a lad, I saw her sticking in the stocks—was always a failure, because she was outside the fashion of her time, yet has given rise to a host of ocean leviathans of far larger size; the steam-turbine has entered into rivalry with the reciprocating steam-engine; cold storage has revolutionized ocean transport, so that fresh food can be carried from this continent to remote England and Europe. Electricity, then a puling infant, is grown to giant size; not only have we deep-sea telegraphy and mechanical speech in the form of the phonograph and telephone, but wireless communication, the electric light, electric transmission of power, electric traction—even the waterfalls of the world are tamed through the turbine and made subservient to our will for motive purposes or in the production of temperatures bordering on those of solar heat, by means of which, too, we can draw food for plants, at will, from our atmosphere, by combining its constituents into the form of a fertilizer. The use of oil-fuel in the internal-combustion engine has been made possible and, in a few short years, our streets have been cleared of horse conveyances and crowded with motor-vehicles; such engines are coming into use everywhere and have enabled us successfully to perform the feat which Dædalus vainly attempted—we even talk of flying from New York to London, across the vast Atlantic, to spend the week-end. The cyanide process has been introduced into gold-mining and is enabling us to unearth a fabulous wealth; a vast array of gorgeous colors has been produced, and Dame Nature so outwitted that we make indigo and madder out of the tar which in old days was put only upon fences; Pasteur's work has made Listerism possible, so that nothing is now beyond the surgeon's art and bacteriology is become the handmaid of preventive medicine and sanitary science; not only paper, but a silk is made artificially from wood-pulp and the finest of scents are conjured

out from all but waste materials. A multitude of other discoveries of practical value might be referred to.

Not so long ago, when scientific research was spoken of, the cry was always, *Cui bono?* What's the good of it all? Now, no one has the patience to listen to a recital of the benefits accruing to mankind from its operation; for all the achievements I have referred to *are not the work of mere inventors,* but primarily the outcome of scientific discovery: thus our modern command of electricity is very largely traceable to the labors of the great philosopher Faraday, who worked in an ill-lighted and cramped laboratory in the Royal Institution in Albemarle Street, London, with no other object than that of contributing to the advancement of knowledge.

Perhaps the greatest of all the scientific achievements of our time remains to be mentioned—the promulgation of the doctrine of evolution by Charles Darwin. Few, perhaps, can realize what this means for mankind, the intellectual advance it constitutes—that through it we have at last acquired full intellectual freedom and the belief that it rests with ourselves alone rightly to order our lives; that by it all dogmas have been undermined.

Science is come into being and has prospered only since freedom of thought was secured: on no other terms can it be. It is well that we should bear this in mind. The growth of numbers and of democracy may well involve a restriction of freedom in all directions—none are so intolerant as the ignorant.

If in science, to-day, we have something unknown to former civilizations, what is its influence to be on the future of the world, in particular on the future of the white people? If we are not to suffer the rise and fall which all previous civilizations have passed through—rather let me say, if the period of our fall is to be retarded beyond the period our forerunners enjoyed, it will be solely because we wield and use the powers science has put into our hands: not so much those of abstract science, but the broad wisdom which the proper cultivation of science should confer; hence it is that I desire to urge the absolute importance of giving, through science, a place to the cultivation of wisdom in the state and therefore in education.

Clearly, two new forces are at work in the world: not science alone, but also a broad and altruistic socialism, both the outcome of the intellectual freedom man has acquired since the deposition of the churches. The one is gradually leading us to base our actions upon knowledge and to be practical through the use of theory; the other is leading us gradually, though slowly, to have consideration for one another, to recognize how helpless are the majority, how greatly they stand in need of the guidance of the few who are capable of leading. But we shall need to order our socialism by science to make it a wise socialism. The signs are only too numerous that a wave of political despotism may come over us. Either, as time goes on, science will be more and more of service in guiding the social machine—or that machine will perish, from the very complexity of its organization and the inability of the units to understand their place, to understand the need of subordinating their individual inclinations to communal interests; most important of all, to understand their inability to recognize and require competent leadership—for science is aristocratic in its tendencies: indeed, I shall claim that real science—wisdom—is for the very few.

With all the marvelous growth of achievement to which I have referred, there has been no proportionate growth of public intelligence. Our admiralty, and to a far

less extent our war office, have called science into their service, but our public departments generally will have none of it. Even the elements of an understanding of the methods of science are not thought to be essential to the education of a civil servant; such knowledge is not required even in the highest branches of the Indian service—no politician is for one moment supposed to need it: we are governed almost entirely by the literary spirit.

The spirit of the age, in fact, is in no way scientific, though ease and comfort are now provided on an unprecedented scale through the agency of science, the engineer acting as chief interpreter. Why do we still go naked and unashamed of our ignorance of "science"? One main reason is that the party in power is unscientific; but at bottom, I believe, the difficulty is a far greater one and probably innate in our disposition. It can not well be supposed that man is by nature disposed to be scientific. The scientific fraternity, at any time, are, and probably always will be, but a small party—a set of freaks, sports from the multitude. They think and talk in a language of their own, as musicians do. The multitude may listen to them at times, with more or less of pleasure, as they do to music; but it is impossible, and probably always will be impossible, for the many to appreciate the methods and results of the scientific worker. Science, in reality, is a form of art, and true artists are never numerous; moreover, it is admitted that they are born—like Topsy, they must grow, for they are not to be made in numbers. Our schools are for the most part in literary hands: and it would almost appear that literary and scientific interests are antagonistic, so unsympathetic has been the reception accorded to science by the schools.

Parenthetically, let me here deny the accusation not infrequently made by literary writers that the scientific fraternity are trying to oust literary studies from the schools. Nothing could be further from the truth. We are always craving for better literary training; our complaint is that the methods and subject-matter of literary training are far from being properly developed and, especially, that English is neglected in the schools. Huxley stated the real situation in saying,

> Science and literature are not two things, but two sides of the same thing.

The rise of science is due to the introduction of the experimental method. Mr. Balfour, in arguing, as he has done recently, that science rests upon many unprovable postulates and therefore does not differ in method from metaphysics, has made assertions which can not be allowed to pass as correct. True science rests wholly upon fact and upon logic: all else is mere provisional hypothesis—a garment we are prepared to put aside at any moment if cause be shown. We are well aware that human nature is aways intervening to spoil our work; it is human to err and false doctrine may easily occupy the attention for a time, but we are fully conscious of our limitations and prepared to admit them, whilst we feel that we are ever advancing towards security of knowledge.

The method of science, indeed, is the method of the Chancery Court—it involves the collection of all available evidence and the subjection of all such evidence to the most searching examination and cross-examination. False evidence may be tendered and for the time being accepted; but sooner or later the perjury is discovered. Our method, in fact, goes beyond that of the courts: we are not only always prepared to reconsider our judgments, but always searching for fresh evidence; we dare to be positive only when, time after time, the facts appear to warrant a definite conclusion. But there are few instances in

which we have traveled so far. The Newtonian theory of gravitation, the Daltonian theory of atoms, are two striking examples of generalizations which fit all the facts, to which there are not known exceptions; should any exception be met with we should at once doubt the sufficiency of such theories. In cases such as Mr. Balfour has discussed—the problems of metaphysics and of belief—experiment and observation are impossible: we can only resort to speculative reasoning; our belief, if we have one, is necessarily founded upon intangibilities and desires.

There was a door to which I found no key:
There was a veil past which I could not see;
Some little talk awhile of Me and Thee
There seemed—and then no more of Thee and Me.

The awful problem before us at the present time is to decide which direction we will take, to what extent and in what way we have the right to teach things which transcend our knowledge; the way in which truth lies may be clear to some of us, but can never be to the majority. Those who wrap up such matters in a tangle of words are not helpful, to say the least. However mellifluous the terms of Bergsonian philosophy may be, they do not bear analysis when the attempt is made to interpret them; their effect is merely sensuous, like that of cathedral music.

But in order that she may lead, science must herself set an unimpeachable example —far too much that is now taught under the guise of science is pure dogma; in fact, the philosophy of the schools is mostly dogma. The true legal habit of mind is insufficiently cultivated and but rarely developed even among scientific workers—our logic is too often imperfect. In science, as in ordinary life, party politics run high and scientific workers are usually, for the time being, party politicians. We are too often crass specialists, always very human: indeed, whatever the lines along which evolution has taken place, they can not well have been such as to favor in any considerable degree the development of the proclivities which distinguish the scientific inquirer: time after time, doubtless, he has been knocked on the head.

The difficulties under which science labors in our schools are partly internal, partly external. Tradition and the type of mind of the average teacher favor set lessons and literary study by blocks of learners; the extra cost of the work is considerable, when the expense of the special requirements is taken into account; more time and more individual effort are demanded both from teacher and from taught; freedom is hampered by the need of considering the requirements of external examinations; finally, the universities have done but little to help, and though the schools have more or less unwillingly recognized that there is some value in scientific studies, in consequence of the persistent demands men such as Huxley have made, more especially because it is seen that there is money in them, none the less there is still no real demand for them on the part of the public. Of this and, in fact, of nearly all the real problems of education, the public are too ignorant to be judges.

Having been more than forty years not only a teacher, but also a student of students and of teachers, of educational methods, and of the conditions under which teaching is carried on, I have been led to form very definite opinions, the more so as I have been able to regard the problems not only from the pedagogic side, but also from that of the chemist and biologist—with some knowledge of the mechanism.

My view—and it is one that I desire to press to a logical conclusion—is that we must recognize that human ability is not merely a limited quantity, but that it varies

enormously not only in quantity, but also in quality: the human orchestra contains a great variety of instruments differing in tone and range, but nature, like man, makes few instruments of superlative excellence, a vast number of very poor quality and only a moderate proportion of serviceable type. If science can tell us anything, it is that the democratic and republican ideal of equality is the veriest moonshine—a thing that never has been and never will be. And education can do very little to alter the state of affairs: it can not change the instrument, at most it can develop its potentialities, and it may easily, by careless handling, do damage to the working parts. To take a special case, of interest at the moment, no contention is less to be justified, I believe, than that which has been put forward frequently, of late years, on behalf of women—that their disabilities are in no small measure due to the fact that we have neglected their education: give them time to educate themselves and they will be as men in all things. Years ago, at our Stockport meeting, I ventured to express the difference by saying that woman is not merely female man, but in many respects a different animal: the two sexes have necessarily been evolved to fulfil different purposes. Nothing is more instructive in the history of modern educational progress than the fact that women have asked merely for what men have: at the universities they have attended the men's courses; not one single course have they demanded on their own account. Higher teaching in relation to domestic science so-called has only been thought of very recently and mainly because men have urged its importance. Most serious and, I believe, irreparable injury is being done to women, in London especially, by forcing them to undertake the same studies and to pass the same university examinations as the men: and the damage is done to the race, not merely to individuals, as the effect of education, whether direct or indirect, is clearly to diminish the fertility of the intellectual. Some day, perhaps, when the present wave of selfishness has passed over us, a rational section of women will found a woman's university where women can be taught in ways suitable to themselves without injury to themselves. In saying these things, of course, I am laying myself open to the charge of narrowness—in deprecation I can only say, that what we are pleased to call education is, for the most part, so futile in substance and in its results that I shall not mind in the least if I am accused of decrying it: in my opinion, we shall all be better without most of it, men and women alike. So far as so-called intellectual education is concerned, learning to read seems to me to be the one thing worth doing: at present it is the thing most neglected in schools.

To develop a rational system, we need to take into account man's past history and to apply evolutionary and biological conceptions. Education, as we know it and practise it, after all is a modern superstition—something altogether foreign to the nature of the majority of mankind; it is based on the false assumption that we can all be intellectual; whereas most of us can only use our hands. But the schools neglect hands and attempt the impossible by trying to cultivate non-existent wits. Man is doubtless pretty much what he was, and it is useless trying to make of him what he has never been.

We are seeking to educate all. What does this mean? Practically that we are seeking to teach all to read. But when they have learned, what are the majority to read—what will they care to read? At the schools for young gentlemen, the reading taught hitherto has been mostly the reading

of Latin and Greek. We know the result—the number of persons above school age who can and do read either language is negligible. Some of us learn French, scarcely any learn German, Spanish is all but neglected: when, therefore, we visit the Continent of Europe or South America we can only mumble a few words of the language of the country, and usually allow the foreigner we visit to speak broken English for us: few of us read his literature.

The vain attempt is made to put us in touch with the past, but no real effort is exerted to bring us into contact with the present. We have not yet taught English in our higher schools, but are beginning to think of doing so—to this end, we are urging that attention be paid to so-called classical literature, forgetting, of course, that for the most part this was written for grown-ups and not as food for babes of school age.

The difficulty is still greater in the case of those who have only passed through the elementary schools—the literature that will appeal to most of these will be very limited in scope. Our newspapers show pretty clearly what will go down: not much—but it represents what is going on in life. In London, when the theaters are under discussion, it is often said that people want to be amused, not instructed; to cudgel our dull brains is a dull business to most of us. It seems to me that this doctrine should be applied more than it is in the schools. At all events, we shall do well to remember the words of the wise pundit in Rudyard Kipling's "Kim": "Education—greatest blessing when of best sorts—otherwise no earthly use."

To discover the best sort for each sort of student is our difficulty—who will do it? Here comes my point. Not the present race of schoolmaster or of educational authority. By placing classical scholars in charge, we seem unconsciously to have selected men of one particular type of mind for school service—men of the literary type; and this type has been preferred for nearly all school posts, mainly because no other type has been available, this being the chief product of our universities. Such men, for the most part, have been indifferent to subjects and methods other than literary—I verily believe not because they have been positively antagonistic or lacking in sympathy, but rather because of their negative antagonism: of an innate inability to appreciate the aims and methods of any other school of thought than their own, especially on account of their entire ignorance of the experimental method. I believe, moreover, that the difference is fundamental and temperamental, not to be overcome by training. Oxford, owing to the bait of its classical scholarships, seems to have attracted an entirely peculiar type of ability and to stand alone in consequence; at Cambridge, owing to the hold obtained by mathematics, the field has been divided, but the mathematician, in his way, is often as unpractical by nature as the classic; fortunately, of late years, owing to the rise of the medical school and that of natural science, other elements have been introduced and the university has a future of infinite promise in consequence, if it will but realize that its primary function is to inculcate wisdom rather than to give purely professional training.

Sympathy is only begotten of understanding; the literary type of mind apparently does not and can not sympathize with the practical side of modern scientific inquiry, because it has neither knowledge of the methods of experimental science nor the faintest desire for such knowledge.

We need a more practical type of mind for our schools. Pessimist though I may appear to be, having watched with close

attention, all my life, the great struggle that has been going on in and between schools—having had the great good fortune also myself to be one of the early workers in the province of technical education, and having been associated with the development of one of the greatest of our boarding schools (Christ's Hospital)—I am, of course, aware that very great progress has been made, and am, in every way, hopeful of the future in store for those who are unaffected by present prejudices. In my experience, the men to whom the progress has been due have, in all cases, been trained in a broader school than that of Oxford; the few escapes from Oxford who have been successful reformers have been the exceptions which prove the rule, as they have shown themselves to be gifted with practical instincts: to such men the Oxford literary training has been of extreme value. Oxford will not gain its full value until all types of ability are represented in fair proportion by its students, not one almost exclusively. When this step is taken, the incubus of the Oxford spirit will no longer be upon us: it will then be possible for us to regard education as "a preparation for life"—a formula often used but usually honored, hitherto, in the breach, rarely if ever in the observance, in our schools.

There must be no misunderstanding. The representatives of literary training rely chiefly on a past into which it is well not to look too closely and must always work with borrowed capital in the days to come: our side has no distant past worth speaking of, but is hopeful of a glorious future, in that it will always be adding to its knowledge; we desire to do their party all possible justice, and shall ever be in need of their assistance and more than grateful for the service they render us; but it must be war to the knife if they will not recognize that, in a progressive age, they can not lead any longer, that we shall decline to put up in future with the conceit and narrowness of outlook of the classical scholar.

The argument I have applied to the teacher is equally applicable to the taught—boys and girls, indeed students generally, are of different types; they have different orders of ability and can not be treated as if all were alike. In the beginning, we may tempt them with all sorts of scholastic diet, but only, in the main, in order to discover their aptitudes; when these are found, they should be the main line of attack. In saying this, I am not arguing in favor of extreme specialization, but against time being wasted in attempting the impossible. Some of us can learn one thing, others another: the schools try to force too many into one mould. It is essential that we should try to lay certain foundations, but useless to proceed when we find that some of them can not be laid.

This doctrine is applicable especially to the selection of scholars and to the training of teachers and of evening-class students. We select our scholars almost entirely by literary tests—the result is that we select persons of literary aptitude rather than those gifted with practical ability for every kind of service: like necessarily breeds like. By insisting on "grouped courses" we too often oblige students to take up subjects to which they are incapable of paying attention with profit: most of us, probably, have found out that there are many subjects which we simply can not learn, try as we may.

My own experience with students has satisfied me that they not only vary in ability, but that the different classes are of very different types of mind: the engineer tends to be constructive, but not analytical; the analytical introspective habit of mind is more highly developed in the chemist; the biologist rarely has mathematical procliv-

ities. It is useless to attempt to teach all in the same way, and many can learn only very little.

The explanation of Huxley's failure to forecast the future of science lies, apparently, in the fact that men generally *are not* attuned to her ways. I am inclined to think that the "mere man of letters" *will continue* to ignore and despise science—he will lack the peculiar mental capacity to assimilate scientific teaching. Only the few will rise to a proper understanding of the mysteries and be masters of their subjects, though many may be trained to be skilful mechanics.

The extent to which the multitude can receive instruction is a matter of primary importance. If, as Huxley has said, the greatest intellectual revolution mankind has yet seen is now slowly taking place by the agency of science—if she be teaching the world that the ultimate course of appeal is observation and experiment, not authority; teaching it the value of evidence: then must we strive to teach all, in some measure, what constitutes evidence, what observation and experiment are.

I believe much can be done in this direction, having made the attempt with hundreds of unwilling students in my time, students of engineering who had not only made up their minds that they were not going to learn chemistry as it was not their subject, but were incapable of ever entering into the spirit of the work—one of my sons was amongst them. At an early period, having realized that it was useless to waste my time and theirs in the struggle, and that it would not help them in the long run, to give them chemical tips which they lacked the sense to appreciate and to apply, I made up my mind, therefore, that it was desirable instead to develop any detective or inventive spirit that might be in them, so advised them to read detective stories instead of a text-book and ask themselves what the stories taught them: how the detectives set to work. Their attention was secured by urging them also to think what would be their position, later in life, when they were called upon to act for themselves and to get new knowledge for themselves, if they had not learned to think for themselves. We have then set them to work to solve a series of problems in the laboratory. The course, in fact, was a combined laboratory-lecture course, the lectures being on and always subsequent to the laboratory work. In not a few cases, in after years, when I have met old students, they have told me spontaneously that, much as they had objected to the pressure put upon them, our insistence on their learning to do something themselves had proved to be of extreme value. Long experience has convinced me that any one who has once learned to make simple measurements and observations and to ask and answer a definite question experimentally is on a different mental and moral plane from that occupied by those who have had no such training.

Such teaching is possible even in elementary schools—given competent teachers; but a new race of teachers will be required to carry the work into effect, should it be decided to make the attempt at all generally.

The great mistake that has been made hitherto is that of attempting to teach the elements of this or that special branch of science: what we should seek to do is to impart the elements of scientific method and inculcate wisdom, so choosing the material studied as to develop an intelligent appreciation of what is going on in the world. It must be made clear in every possible way, that science is not a mere body of doctrine, but a method: that its one aim is the pursuit of truth.

If we are to progress in these matters, a system must soon be developed which is broader and better than that under which we now muddle along—at present the real problems of education are all but neglected; even if the official mind were capable and desirous of promoting progress, the work of administering rules and regulations—of keeping the machine going—is so great that no time is left for thought.

We have seen the error of our ways sufficiently to give up payment by results, and are all but ashamed that we were ever misled by Robert Lowe to adopt such a soul-killing policy. But none the less our entire educational system is still in the grips of commercialism, and, in this respect, as a nation, we stand alone, I believe. Scholarships, prizes of one kind or another, examinations are the perpetual feast of British education. Examinations, in fact, are a regularized and very lucrative branch of industry—mostly in the hands of certain firms who diplomatically shelter themselves under the ægis of this or that educational body; but the universities are the greatest sinners. Valuable as examinations may be within certain narrow limits and for certain definite purposes, there is little doubt that our general ignorance is in no small degree determined by our worship of the examination fetish. So long as the system prevails, the education of our youth will not be in accordance with either their capacity or their requirements, but on lines corresponding to those by which prize cattle are raised for show—they will be trained to develop some specially catching point.

The examinations are an inheritance from the literary rule. It is possible to test on paper whether a man be "well read," but faculty as distinct from capacity can not be so determined. What is worse, by forcing students to commit a large body of doctrine to memory, the attention becomes fixed merely upon what others have done and little time or inclination is left them to acquire a knowledge of method—the faculty of thinking for themselves and applying their knowledge. No class suffers more seriously than medical students under the system—their preliminary training is all but entirely didactic, and the time spent upon it all but wasted; we need not wonder that medicine has made so little advance, the practitioners being in no way trained in the use of scientific method.

To improve our system we need to get rid of our blind British belief in "men of affairs," especially in the "man of business," so-called, really the man of commerce, as persons capable of ordering everybody's affairs and everybody's business. The commercial man, the financier or the lawyer, would never think of calling us in to manage his proper business—why should he be thought competent to manage ours? Results show that he is not, as my argument in this address would lead us to expect would be the case.

No one will seek, for one moment, to minimize the progress made or fail to recognize that infinite credit is due to those who have controlled the work of education thus far; hitherto, however, progress has been made in providing accommodation and getting scholars to school and college: the art of teaching has made no corresponding advance—nor will it, I believe, until the onus is cast more directly upon the teachers and they are forced to exercise greater forethought in the direction of collective action—until they are placed in a position to be sole managers of their own affairs and called upon to row together as entirely self-chosen crews. At home, excepting at our ancient universities, "governing bodies" are paramount everywhere—not the teachers; and too often the sense of

responsibility and power of initiative of the teacher are further diminished by the interposition of a principal, who may be a man of all affairs except that in hand—the work of teaching.

If the conclusion at which I have arrived be correct—that science is not for the multitude and can never be generally appreciated or even fashionable—in view of the part which it is clearly destined to play in education and in daily life, on account of its infinite and far-reaching influence upon our well-being—the responsibility cast upon the few representatives of science is very great; in support of our civilization and in order that wisdom may prevail more generally, they must organize its forces effectively.

Whilst individuality is the mainspring of scientific progress, collective action is required to provide full and proper opportunity for the workers and to promote the success of their inquiries. At present, scientific workers are organized merely for the purpose of providing means of publishing the results of their studies, in no way either for defence or offence; our societies are not effective even for the purposes of debate and criticism. Thus, our chief English scientific society, consisting of some 500 members representative of all the various branches of physical and biological science, is little more than a rabble—its fellows are such individualists that scarce half a dozen of us can ever agree to work seriously together for a common purpose, and the irresistible influence we might exercise if we could be unanimous as to our objective is lost to the community. Most unfortunately, the society has no influence whatever either on political or on public opinion; it makes no attempt either to guide the public or to give dignity and importance to the cause of science in the eyes of the community. Its meetings are dull, and its belated publications by no means represent the scientific activity of its fellows. The presidents of the society have too often been appointed at an age when the propagandist spirit is no longer paramount, when they have no particular scientific message left in them to deliver. And they occupy the chair too long; this arises chiefly from the fact that however clear each one of us may be that individually he is fully competent to hold the office, we all agree in finding some objection to every name that is suggested; to overcome this difficulty a short tenure is desirable, so that the compliment can be paid and encouragement given to the various sciences in turn; no one should be appointed to such an office who is more than sixty to sixty-five years old, as most of us have used up our ideas and have lost our virility by that age. The other officers also hold their positions too long, but members of the council have far too short a life—consequently all the power is centered in the official body; attempts that have been made to organize the whole society in sections representative of the various sciences have always been defeated by the official party.

Unless our scientific societies can be made more generally effective, if scientific workers are incapable of learning lessons from administrative life, it stands to reason that the collective interests of science and of the body scientific must remain unrepresented and unvoiced—to the great detriment of progress and of the public.

Science must be organized, in fact, as other professions are organized, if it is to be an effective agent in our civilization; the problems pressing upon us are of such magnitude and of such infinite importance that we can no longer afford to be without wisdom.

HENRY E. ARMSTRONG

THE SAN FRANCISCO MEETING OF THE AMERICAN PHYSICAL SOCIETY

The American Physical Society will unite with Section B of the American Association for the Advancement of Science in a joint meeting to be held at San Francisco August 2 to 7, 1915.

The program of the meeting is in special charge of the Pacific Coast Committee of the American Association for the Advancement of Science and will differ somewhat from that of ordinary meetings. The presentation of the results of individual research in short papers volunteered by their authors will be a minor feature of this meeting, but several sessions will be devoted to a somewhat broader consideration of the larger questions of physics, particularly those which have engaged the attention of Pacific coast workers. At these sessions only papers given on invitation will be presented. One session will probably be devoted to spectroscopy and another to atmospheric physics, the latter in charge of Professor W. J. Humphreys.

On Wednesday, August 4, the society will visit Stanford University and Professor Harris J. Ryan will give demonstrations with high-potential electric currents in the new laboratory especially equipped for such work. The meetings on other days will be held at the University of California at Berkeley. On Friday the officers of the Physical Society will have charge of a session—or two if necessary—at which ordinary research papers will be presented. It is hoped that the western workers who do not often have an opportunity to attend our meetings may be conspicuous on this program and their contributions are especially requested. Visiting members from the east are not urged to present many papers, as time will be somewhat limited.

Physicists are invited to attend the joint sessions of the American Mathematical Society and the American Astronomical Society at Berkeley, Tuesday forenoon, August 3. An address will be given by Professor C. J. Keyser, of Columbia University, New York, on "The Human Significance of Mathematics," and by Dr. George E. Hale, of Mt. Wilson Solar Observatory, on "Recent Progress in the Development of Astronomical Science."

An excursion to Lick Observatory has been arranged for Friday, August 6, by the American Astronomical Society. The observatory may also be visited on any day of the year from 8 A.M. to sunset, and on Saturday evenings by those arriving before 9 o'clock. Saturday evening visitors have the privilege of observing the stars with the 36-inch and 12-inch telescopes. The railway station for the Lick Observatory is San Jose. An auto-stage leaves San Jose on six days of the week at 8:30 A.M., stops at Smith Creek Hotel for luncheon and reaches the summit of Mount Hamilton before noon. The stage departs at 1:30 P.M. and reaches San Jose before 4 P.M. The round trip fare for the individual trip by auto-stage is $5.

The director of the Mount Wilson Solar Observatory extends a cordial invitation to men of science interested in astronomical and physical research to visit the observatory either before or after the San Francisco meeting of the association. The shops and laboratories in Pasadena and the observatory buildings on Mount Wilson will be open, and all phases of the work in progress can be seen. The Mount Wilson Hotel Company maintains a daily auto-stage service between Pasadena and the summit, where comfortable accommodations for the night may be found at the hotel. If time is limited, the round trip from Pasadena can be made in a day. The auto-stage leaves the office of the company (173 E. Colorado Street) at 9:30 A.M., reaching the summit at 11:45 A.M. On the return trip the stage leaves at 3 P.M., and arrives in Pasadena at 4:45 P.M. The round trip fare is $3.

The director of Congresses of the Panama-Pacific Exposition has organized a special convention news bureau to give due publicity to papers and proceedings of organizations meeting in San Francisco and vicinity. This will include the preparation, in advance of the meeting of articles for the daily press and for magazines, reporting each session for daily press and news agencies and in some

cases preparing full reports of meetings for magazines.

RAILROAD ROUTES AND RATES

From Denver to San Francisco and return	$45.00
From Omaha or Kansas City and return	50.00
From St. Louis or New Orleans and return	57.50
From Chicago to San Francisco and return	62.50
From Detroit to San Francisco and return	73.50
From Cincinnati to San Francisco and return	71.10
From Cleveland to San Francisco and return	76.20
From Pittsburgh to San Francisco and return	81.20
From Buffalo to San Francisco and return	83.50
From Washington to San Francisco and return	92.30
From Philadelphia to San Francisco and return	92.95
From New York to San Francisco and return	94.30
From Boston to San Francisco and return	100.70

Tickets from Chicago, St. Louis and similar territory are good *via* New Orleans, returning by the same or any other direct route. All rates apply *via* Los Angeles. Round trip tickets going or returning *via* Canadian or northern lines through Prince Rupert, Victoria, Vancouver, Seattle or Portland, Shasta Route (rail) or steamship between these points and San Francisco are $17.50 higher (berth and meals included on steamer from Prince Rupert to Seattle). The usual stop-over privileges will be allowed on both going and returning trip. Journey out may be taken *via* one route and return by another, and the above rates are good for 90 days from date of sale. Railroads participating in this arrangement include the Grand Trunk, Canadian Pacific, Great Northern, Chicago, Milwaukee and St. Paul; Northern Pacific, Southern Pacific, Union Pacific, Denver and Rio Grande, San Pedro, Los Angeles and Salt Lake, Santa Fe and Mexican Central. The Panama-California Exposition at San Diego is reached by rail from Los Angeles by the Santa Fe Railway and transcontinental excursion tickets by way of Los Angeles will include a trip to San Diego and return without extra charge, but *only if arrangement for it is made at the time the transcontinental ticket is purchased.*

Special lines of steamers advertise passage between Atlantic and Pacific Coast by way of the Panama Canal at rates varying between $135 and $198 (one way).

Stop-overs for side trips can be arranged either going or returning. Round trip rate from San Francisco to Hawaiian Islands and return by either of several lines of steamers from $110 up. Yellowstone National Park is reached from Livingston on the Northern Pacific (to Gardner and return $3.20). A six-day trip in the park from Gardner costs $40 and another of 5¾ days $53.50. Yellowstone Park may also be reached from Ogden on the Union Pacific by a branch to Yellowstone (round trip $9.25). From here a five-day trip in the park costs $35 and a six-day trip $40.

The Yosemite National Park is reached by Southern Pacific or Santa Fe lines, stopping at Merced, Cal. Round trip from Merced to Valley $18.50.

Both hotels and comfortable camps may be found at the camp. Several groves of Big Trees may be visited from the Valley. One grove very much visited is only six miles from Santa Cruz (on the Southern Pacific).

Alaska may be visited by steamer trip from Seattle or Vancouver. Round trip from Seattle $66 and up. From Prince Rupert (on Grand Trunk) a trip to Alaska may be made at an additional expense of about $30.

The Official Hotel Bureau of the Panama-Pacific International Exposition, with which are affiliated about 85 per cent. of the hotels of San Francisco and vicinity, guarantees that the rates of hotels associated with the bureau will not be advanced during 1915. Schedules of rates of the hotels may be secured from this bureau (address, Exposition Building, San Francisco).

Further information in regard to programs, travel connections, etc., may be secured by addressing Albert L. Barrows, associate secretary, American Association for the Advancement of Science, University of California Library, Berkeley, California.

The columns of SCIENCE will contain further announcements.

A. D. COLE,
Secretary

SCIENTIFIC NOTES AND NEWS

The seventieth birthday of Professor Elie Metchnikof, was celebrated in Paris recently, though the international Festschrift planned in his honor has been abandoned. At the exercises Professor Darboux spoke on behalf of the Paris Academy of Sciences and Dr. Roux on behalf of the Pasteur Institute.

Mr. Thomas A. Edison was given the degree of doctor of science by Princeton University, at its recent commencement.

Honorary degrees were conferred at the recent commencement of George Washington University upon men of science as follows: doctor of laws, William H. Dall, of the U. S. Geological Survey and the Smithsonian Institution, and Otto H. Tittmann, lately superintendent of the U. S. Coast and Geodetic Survey; doctor of medicine, Shepherd I. Franz, of the Government Hospital for the Insane.

The University of Pittsburgh has conferred the degree of doctor of science on Reid Thomas Stewart, professor of mechanical engineering and for thirty years a teacher in the University of Pittsburgh.

The Howard N. Potts gold medal of the Franklin Institute has been awarded to Dr. W. J. Humphreys for his paper "The Thunderstorm and Its Phenomena."

Professor Bashford Dean, of Columbia University, has been elected an honorary member of the Société Zoologique de France in recognition of his contributions to the embryology of vertebrates.

The medical faculty of the University of Heidelberg has awarded the Kussmaul medal and the prize from the Kussmaul endowment to the surgeon, Professor Braum of Zwickau.

Professor Henrik Mohn, the distinguished Norwegian meteorologist, has celebrated his eightieth birthday.

Admiral Sir Henry Jackson, K.C.B., who has been appointed first sea Lord of the British Admiralty, is a fellow of the Royal Society and is known for his researches on electrical physics.

Dr. John R. Murlin, assistant professor of physiology in Cornell University Medical College, New York City, has declined the permanent position of biochemist at the pellagra hospital of the U. S. Public Health Service at Spartanburg, S. C. He has also declined the professorship of physiology and physiological chemistry at Fordham University Medical School.

With the aid of the fund given to the university by Mrs. Amey Richmond Sheldon, the Harvard division of geology has sent W. G. Foye, assistant in the division, to Fiji. In that archipelago he will study the coral reefs, the uplifted limestones and the volcanic rocks. He will soon be joined by W. M. Mann, of the Bussey Institution at Harvard. Also as a Sheldon fellow, Mr. Mann will specially consider the distribution of organic species in its relation to the origin of the islands and reefs. Their joint investigation is planned to last nine to twelve months. Another Sheldon fellow, Sidney Powers, is spending six months on an investigation of the volcanoes and igneous rocks of the Hawaiian Islands.

Dr. Joseph E. Pogue, associate professor of geology, Northwestern University, sailed on June 15 from New Orleans for a three months' visit to Colombia, where he will carry on geological studies in the Andes near Bogota.

Maurice Parmelee, who took the degree of doctor of philosophy at Columbia University in 1909, has been voted the Squires prize by that university. This prize is awarded quinquennially "to such graduate conducting an original investigation of a sociological character as shall be adjudged most worthy by a committee of award, consisting of the president, the professor of sociology and one of the professors of political economy. Such award shall be deemed to be a recognition of scientific ability and achievement, as well as an encouragement of research." Mr. Parmelee is now engaged in literary work of a sociological nature in New York City.

Another surgical unit, made up almost exclusively of Harvard surgeons, will sail from New York on June 22 for service in one of the field hospitals of the English army. The location of the hospital has not been

divulged, but it is probably in England. Most of the thirty-four members of the unit have been taken from the staffs of the Boston City Hospital and the Massachusetts General Hospital, but a few have come from suburban hospitals. Dr. E. H. Nichols, associate professor of surgery and visiting surgeon to the City Hospital, will be in charge of the unit. Other senior surgeons are: Dr. William E. Faulkner and Dr. John I. Thomas, both of the City Hospital, and the following from the Massachusetts General Hospital: Dr. Charles A. Porter, Dr. Franklin G. Balch, Dr. Alexander Quackenboss, Dr. Harris P. Mosher, Dr. Walter J. Dodd and Dr. Roger I. Lee, who is professor of hygiene at Harvard.

FREDERICK G. CLAPP, of Pittsburgh, has recently returned from a year and a half spent in geological explorations in China.

THE University of Pennsylvania Museum has heard from its expedition to Siberia, under the leadership of H. U. Hall. A letter has been received from him at Monastir, on the Yenisei River, the first civilized place reached after a long winter within the Arctic Circle, between the Yenisei and the Lena Rivers. The letter was dated April 1, and announced that the river would be open in two months, after which time he would start for the United States.

PROFESSOR ROBERT F. GRIGGS, of the department of botany of the Ohio State University, has left for Kadiak, Alaska, to make investigations for the National Geographic Society on the vegetation of volcanic ash deposited by eruptions of Mount Katmai. His study will be a continuation of similar observations which he made during a trip to Alaska two years ago.

THE commencement address at Case School of Applied Science was delivered by Mr. William C. Redfield, secretary of commerce. The address before the Case Chapter of the Sigma Xi during commencement week was delivered by Mr. Charles F. Brush, on "Early Recollections of the Electric Light Industry."

AT the April meeting of the Virginia Chemists Club a telegram was read from Secretary Chas. L. Parsons, of the American Chemical Society, announcing that the club had been made a section of the American Chemical Society, to be known as the "Virginia Section." Dr. Alexander Smith, of Columbia University, was the guest of honor at this meeting and addressed the club on "The Teaching of Live Chemistry." Dr. Smith was elected an honorary member of the new section.

DR. VICTOR C. VAUGHAN, dean of the medical faculty of the University of Michigan, and president of the American Medical Association, delivered the address at the annual commencement of Jefferson Medical College, Philadelphia, on June 15, his subject being "A Doctor's Ideals."

ON the evening of June 12 Professor Cassius J. Keyser, of Columbia University, made the annual address before the local chapter of the Society of Sigma Xi at the University of Washington. The subject of the address was "Science and Religion, or the Rational and the Superrational." On June 16, he delivered the commencement address at the University of Oregon, speaking on university ideals as the light of life.

IT was stated in a recent issue of SCIENCE in accordance with information sent us that Professor A. G. Webster had given a lecture at Oberlin College on "Business and Kultur." We are now informed that the title was "Physics and Kultur."

DR. JOHN H. MCCOLLOM, seventy-two years old, professor emeritus of contagious diseases at the Harvard Medical School, died on June 14.

LIEUT.-COL. CHARLES E. WOODRUFF, U. S. A., retired, died on June 13, aged sixty-five years, at his home at New Rochelle, N. Y. In 1886 he entered the United States navy as a surgeon. A year later he resigned and entered the army with the same grade. He was chief surgeon of brigade on General Merritt's staff in the Philippines. He went round the world inspecting the sanitation of foreign army posts and later the sanitary conditions of Germany and several other European countries for the United States government. He was the

author of "The Effect of Tropical Light on White Men" and "Expansion of the Races."

Dr. Hugo Müller, F.R.S., past-president of the British Chemical Society, died on May 23, aged eighty-one years.

Sir A. H. Church, F.R.S., formerly professor of chemistry in the Royal Academy of Arts, London, died on May 31, at the age of eighty years.

The death is announced of M. Pierre Martin, known for his work on the metallurgy of steel.

Dr. Oswald Lohse, head astronomer in the Potsdam Astrophysical Observatory, has died at the age of seventy-one years.

Grand Duke Constantine Constantinovitch, who died on June 15 at the age of fifty-seven years, was actively interested in science and letters. He was at the time of his death president of the Imperial Academy of Sciences.

Dr. Johannes Schlunck and Dr. Erich Meyer, geologists, of the German survey, have been killed in the war.

Lead is one of the first metals that would naturally be associated with an increased consumption in time of war, and yet the exports of lead from the United States to Europe since the war began have not increased in proportion to the increase in exports of zinc and some other metals, and the price of lead instead of being enhanced by the war actually slumped in October to the lowest point reached in the last fifteen years. These and other facts are graphically presented in the advance statement of the production of lead in the United States in 1914, just issued by the United States Geological Survey. The total production of refined lead from both domestic and foreign ores was 542,122 short tons, compared with 462,460 tons in 1913. The production of refined lead from domestic ores was 512,794 tons, an increase of 100,916 tons over the record figures reached in 1913. This increase was due chiefly to gains in Missouri, about 42,000 tons; in Idaho, 40,000 tons, and in Utah, 18,000 tons. The exports of lead smelted from foreign ores were 30,944 tons and from domestic lead ores 58,722 tons, a total of 89,666 tons, larger than in any other year since 1911, when the exports of lead aggregated 113,307 tons. No domestic pig lead had ever been exported from the United States prior to 1914. Generally the price of lead in this country, owing to the tariff, exceeds the price abroad. Lead smelted in bond from foreign ores is therefore exported instead of domestic lead. Owing to the civil war in Mexico the imports of Mexican ore for the last few years have been much smaller than heretofore, and there was not enough foreign lead in the United States to supply the demand. Lead was consistently higher in London in 1914 than in New York, and this, together with the scarcity of Mexican lead, caused the large exports of domestic lead.

UNIVERSITY AND EDUCATIONAL NEWS

Dr. Arthur A. Noyes, of the Massachusetts Institute of Technology, is to become a member of the faculty of the Throop College of Technology, Pasadena, Cal., for a portion of the coming academic year, and for one half of the time in succeeding years, beginning with 1916–17, this arrangement having been made possible by a gift of $10,000 for the equipment of a physical chemistry laboratory, and the endowment of this laboratory in a sum yielding $10,000 annually for its support. This laboratory is to be located in a new chemistry building, which is expected to be built during the coming academic year.

Professor Robert L. Sackett, formerly of the civil engineering school of Purdue University, Lafayette, Ind., has been appointed dean of the engineering school of Pennsylvania State College. Professor Sackettt succeeds Professor John Price Jackson, who is now commissioner of labor for the state of Pennsylvania.

At the laboratories of the New York Postgraduate Medical School and Hospital, Dr. Ward J. MacNeal has been appointed director to succeed Dr. Jonathan Wright, resigned. The following promotions have been made: Dr. Morris S. Fine to be adjunct professor of pathological chemistry; Dr. Richard M. Taylor to be adjunct professor of pathology;

Dr. Paul A. Schule to be lecturer in bacteriology.

DR. FLORENCE PEEBLES, of Bryn Mawr, has been appointed professor of biology in Newcomb College, Tulane University, New Orleans.

ASSISTANT PROFESSOR HAROLD A. EVERETT, of the department of naval architecture and marine engineering of the Massachusetts Institute of Technology, has been appointed to the position of professor of marine engineering in the post-graduate department of the United States Naval Academy at Annapolis.

HENRY JOSEF QUAYLE has been promoted to a full professorship of entomology in the citrus experiment station and graduate school of tropical agriculture of the University of California.

MR. H. SCOTT, of Trinity College, Cambridge, has been appointed curator in entomology in the university.

DISCUSSION AND CORRESPONDENCE

THE FUNDAMENTAL EQUATION OF MECHANICS AGAIN

TO THE EDITOR OF SCIENCE: I have followed with the utmost interest the correspondence in SCIENCE on the proper method of teaching the relation between force, mass and acceleration, and have heretofore refrained from adding to the discussion. I am mindful that there must be many readers of SCIENCE who have not had any advanced courses in mechanics, but who are trying to present to their students this equation, adaptable to any system of units, in a way that does not seem artificial. The difficulty of teaching this properly to students who have had little practical experience, and no occasion to do any amount of computing, and who will probably not go beyond their first course in physics, must be apparent to all. At the risk of being hissed out, I beg your leave to state a method often used, and which I have always found very successful with my classes at Wells College.

I follow a program very much like that outlined by Gordon S. Fulcher in your issue of April 30. I teach the dependence of acceleration on force, using the same mass, etc.; and set up equations in the form of proportions. The combined equation would then be

$$\frac{F}{F_0} = \frac{M}{M_0} \cdot \frac{A}{A_0}.$$

Then following a method similar to that used in books on geometry in the treatment of the area of a rectangle, I say that we may take as our unit of force that force which gives to unit mass a unit acceleration. Then *numerically* $F = MA$; if the unit of mass be the gram, and of acceleration, the cm. per sec. per sec., then the unit of force is called the dyne. All equations in which a force is computed by multiplying a mass by its acceleration, would give the answer in dynes. But the dyne is inconveniently small. A more natural unit is the weight of a kilo. To obtain the force expressed in the larger unit, "we divide the answer expressed in the smaller units by the number of the smaller units contained in the larger unit." Then I go on to explain that this procedure of taking natural units is very common: one person is head and shoulders above another, a certain type of tree is about twice the height of a man, etc. If you multiply the number of square yards in a floor by the price (in cents) of one square yard of carpet, and you want the answer in dollars, divide by the number of cents in a dollar.

It is easy, then, to go over to the British system, in which we have but an artificial analogue of the dyne. Let us fetch that backward baby, the poundal, into the room for an inspection, at least long enough to learn that the weight of a pound is 32 poundals. Then remembering that, for instance, centripetal force, $= mv^2/r$, is in absolute units, we get that force in pounds' weight by dividing by 32.

I have little sympathy for those who "inflict" on their students such absurd ideas as that we measure sugar, stones or anything else in one kind of pounds, but use a different pound when we find the force necessary to accelerate that mass. And the idea of a gravital is equally bizarre.

As for the metric system, I am almost discouraged at the conservatism of this progressive (?) nation. It is perfectly true that it would involve a large expense to change our manufacturing machinery to conform to the

metric standards, but this could happen slowly. Now that so much is said of scientific management, have the owners of large plants ever taken the trouble to estimate the time spent by their computers on account of our adherence to an archaic system? While abroad, I bought me a carpenter's rule in the metric system, and use this in my shop except when I have to use machinery built on the British system. I make fewer mistakes, and have far less difficulty in reading a metric rule than one graduated to sixteenths of an inch.

The metric system has the advantage in classes in physics that we can spend most of our time on physics, and comparatively little on arithmetic, and perhaps our pupils may help to demand the metric system as the universal standard.

PAUL F. GAEHR

PSYLLIDÆ WINTERING ON CONIFERS ABOUT WASHINGTON, D. C.

THE fact that certain Psyllidæ spend the winter upon conifers is well known,[1] but little has been put on record concerning this habit in the United States. In the vicinity of Washington five species of Psyllids abundantly winter on *Pinus virginiana*. I have more than once taken all five on the same day. On a bright day they are very active, hopping quite as vigorously as in summer. The list includes *Livia maculipennis* Fitch, *L. vernalis* Fitch, *Aphalara calthæ* Linn., *Trioza salicis* Mally, and *T. tripunctata* Fitch. The true food plant or host on which these species breed in no case is pine, the conifer being used only as an alternate food plant and winter shelter. The habit of resorting to conifers is not restricted to the cold season, however, as the records show. *Livia vernalis* has been taken on pine in June, July and September, also, *Aphalara calthæ* in April, and *Trioza tripunctata* in April, May and June.

These Psyllids occur on *Pinus tæda* also, and to some extent on *Juniperus virginiana*. Another species of Psyllid—*Pachypsylla c-mamma* Riley—occurs from October to February at least upon juniper and hemlock.

Wintering specimens of two of these species of Psyllidæ differ in appearance from the summer forms. In *Aphalara calthæ* the colors are more pronounced in winter specimens, and in *Trioza salicis* many individuals taken at this season are notably more pruinose than the summer form.

Besides psyllids, a variety of other insects resort to pines in winter. They include leafhoppers of the genera *Empoasca, Erythroneura, Balclutha,* and *Idiocerus,* the cercopid, *Clastoptera,* and the Heteroptera, *Lygus pratensis* Linn., and *Piesma cinerea* Say. *Aradus cinnamomeus* Panz. occurs on these trees throughout the year. The assemblage of winter guests on pine includes also small sawflies, and other hymenoptera, numerous diptera, especially Chironomidæ, and a few beetles and spiders. By beating conifers, scaling off bark, searching through fallen leaves, and sifting, I have made as numerous and varied a catch on many a winter's day, as I have on some days during the more favored season. I may mention that I sought in vain for Psyllids on pines in Maine in early March, getting only diptera and spiders.

W. L. MCATEE

[1] See especially Reuter, O. M., "Hemipteren-Fauna der Palaearktischen coniferen," 1908.

SCIENTIFIC BOOKS

Medicine in China. By the China Medical Commission of the Rockefeller Foundation. New York, 1914.

This volume, containing 113 pages including the appendices, is a summary of the investigations of Chinese medicine by a commission appointed by the Rockefeller Foundation early in 1914. The commission consisted of President Judson, of the University of Chicago; Roger S. Greene, consul-general of the United States at Hankow; Dr. F. W. Peabody, of the Harvard Medical School, and George Baldwin McKibbin. The purpose of the commission was to study the medical schools, hospitals and dispensaries of China with reference to the needs of the country and the desirability of aiding these institutions financially or otherwise. The commission has produced a report which is not only informing, but is full of interest and written in non-technical language.

The statement of the committee that China

probably has the largest death rate of any country in the world is probably correct. The responsibility for this lies fundamentally in the lack of knowledge of both personal and public hygiene on the part of the Chinese people, and in the lack of properly trained physicians, nurses and sanitarians to disseminate such knowledge. The tremendous mortality from which the Chinese suffer is, in the main, due to diseases of parasitic origin. Tuberculosis is widespread, and hookworm and syphilis compete with it as the important causes of death. In addition to these persistent causes, recurrent waves of epidemic disease carry death and destruction to various parts of the great Chinese Empire. Cholera, typhus fever and the plague may be mentioned in this connection. An attack of smallpox is taken for granted by the natives, just as it was in the western world before the introduction of vaccination. The report contains no information as to the prevalence of the degenerative diseases which are increasing so ominously in the United States, but it is safe to assume that they also are present and doing their share of destruction. The most hopeful feature of the health conditions in China lies in the fact that the prevalent causes of death are diseases of infectious origin, many of whose causes are already known and many of which have been almost stamped out, or at any rate considerably restricted, by modern methods of sanitation. The fact also that there are signs that the more intelligent among the Chinese themselves show evidences of an awakening interest in public health matters is of great significance.

The present condition of native Chinese medicine and surgery produces effects more serious and more widespread than the report of the commission would indicate. Doubtless this aspect of the subject has been purposely somewhat lightly touched upon; for the report, to produce its best results in China, must of necessity avoid engendering antagonism. The conditions of knowledge and practise in China to-day are not unlike those which obtained in ancient Greece and Rome. No regulation of practise, in our sense of the word, exists. Any ignorant fakir can practise, and practise is purely empirical. The Chinese prejudices against the dissection of the human body have prevented the development of medicine upon a sound basis of anatomy and pathology, and have resulted in an ignorance concerning these subjects that would be laughable were its remote effects on the public not so terrible. It would be difficult to estimate, according to those who have lived in China, the amount of suffering which results from the lack of knowledge of the Chinese practitioner; and this is not confined to remote country districts, many large cities containing not a single medical practitioner trained in western methods. The few Chinese who have been so trained are mainly connected with the missionary hospitals and are, most of them, graduates of second-grade Japanese schools with low entrance requirements.

The medical schools of China have in the main developed in connection with the hospitals as the result of the urgent need for assistants in hospital work. In a sense, therefore, the development of the Chinese medical school has followed along the developmental lines of the British medical school, rather than the German or the American one. The schools which exist at the present time are, most of them, conducted in association with missionary hospitals and each is usually supported by the cooperation of several missionary societies. In addition to these schools, there are a few government schools, mostly under Japanese influence, and a few independent schools affiliated with American universities such as those associated with Harvard, the University of Pennsylvania and Yale. It is clear from the report of the commission that, as in this country, the medical schools have grown up haphazard at various points, doubtless as the result of very real needs, but, nevertheless, without careful study of the country as a whole in its geographical and educational relation to medical training. Practically none of the existing medical schools is adequately equipped according to western standards. Most of the schools lack the financial resources so necessary to maintain a high-grade medical school.

Practically none of them possess an adequate corps of properly trained instructors able to devote their entire time to the work. The influence of political, sectarian and in some instances personal domination, have been detrimental to the best development of some of the schools. The availability of properly qualified students has not always been considered in the development of Chinese medical schools, nor has cooperation with the Chinese themselves always been developed as it might. There are too many weak schools, and in certain places duplication of effort is to be observed.

The hospitals in China are administered for the most part by the missionary societies. There are a few Chinese Red Cross and government hospitals maintained by foreign organizations other than the religious ones. Many of the hospitals are well constructed along modern lines, but a large number are housed in remodelled dwellings which are more or less unsatisfactory for hospital purposes. The possibility of constructing satisfactory hospitals is not lacking, for building material is available and cheap almost everywhere in China, and labor is likewise cheap. From the standpoint of the construction of modern plants there are, however, some serious drawbacks which scarcely come into account with us. The lack of public sewage systems, the absence of public water supplies even in the large cities, and the lack of gas and electricity in most parts of China make difficult, but by no means impossible, satisfactory hospital conditions. The main difficulties at present have to do with the human rather than the mechanical factors. Practically no Chinese hospital in existence is sufficiently supplied with properly trained physicians. Even more important is the lack of properly trained nurses. The prejudices of the Chinese themselves interfere with smooth and satisfactory administration. The dislike of bathing (a peculiarity not confined to the Chinese), the filthy habits, the vermin-infested clothing of the patients, and the fact that in many hospitals a patient is allowed to bring members of his family permanently into the hospital with him, do not add to the ease of administration. In the dispensaries too, most of which act as feeders to the hospital, the same lack of physicians and nurses is apparent. It is, I think, a fair criticism that in many instances the western physicians in charge of Chinese hospitals have deferred too much to the customs of the Chinese people under the mistaken assumption that this was necessary in order to gain their patronage. There is ample evidence in the report that the opposite point of view, namely, that admission to the hospital is a privilege which the Chinese must pay for by a compliance with the western rules of hygiene, works out well in the end. Indeed, it is obvious that the function of a hospital, not only in China, but anywhere in the world, is not only to administer to the individual patients, but also to spread through them a knowledge of the methods of personal and public hygiene. This certainly can not be done by catering to their unhygienic habits.

The cause underlying the lack of sufficient medical and nursing help in Chinese hospitals is worthy of consideration. It is, apparently, not entirely a financial question, though the salaries paid are, we think, too low. It is poor policy to pay a professional man so low a salary that he spends important energy in making both ends meet which he should be spending on his professional work. It is probable, however, that other reasons than mere salary play an important part in the difficulties attendant upon obtaining physicians and nurses for medical work in the Chinese Empire. So far as the physicians are concerned it must be pointed out that the changes in medical education of the past twenty years, with the natural growth of hospitals and public health work, have resulted in a diminution of the physicians graduating, with a great increase in the opportunities. It is likely, therefore, that the supply of missionary physicians for China will be limited to the comparatively small proportion of medical graduates whose religious fervor or adventurous spirit is appealed to by the great opportunities which undoubtedly exist in the east. The same will doubtless be true of the nursing profession.

The question of the standards of medical

education which are to be upheld in China can surely be settled if the experiences of this country are taken into account. It is clear from American experience with low-grade medical schools catering to students with inadequate preliminary training that inestimable damage may be done, both to the medical profession and to the public, by a policy which permits of such a condition, even though it is proposed with the best of motives. The only rational view, looking ahead into the future, is that those responsible for medical education in China must demand an adequate medical training based upon a sufficient preliminary education, including the fundamental sciences. There is little question that education in China is changing with great rapidity. It seems clear that the social status of the physician is growing in popular respect. It is probable that the number of well-trained young men who are anxious to study medicine is constantly on the increase. Further than this, some of the great obstacles to satisfactory education in medicine, notably the Chinese objection to dissection, are gradually being overcome, and there is evidence that the attitude of the Chinese authorities towards western medicine is rapidly becoming more and more favorable.

The question of the language to be used as a medium for the instruction of the Chinese in medicine is also a matter of dispute even among those who have spent years in China. The most potent argument in favor of a foreign language, such as English, seems to be the lack of literature in the Chinese language. The day has gone by when medicine can be studied by means of text-books alone. Further than this, the medical man must be a student all his life and a student of current literature. There are doubtless many weighty reasons against the use of the English language in Chinese medical education. Few of them, we believe, can have the importance of this one in favor of it.

The recommendations of the commission seem to be founded on a fair estimate of the needs of the situation based on an impartial review of the facts obtained. They suggest the financial support of certain medical schools which are well situated and are capable of requiring and enforcing high standards of medical education. They provide for the establishment of model tuberculosis hospitals and aid in developing the general hospitals which serve the medical schools. They suggest the creation of scholarships for Chinese medical students and nurses, and fellowships for Chinese graduates and western medical workers in China who may wish to refresh their knowledge. They encourage the development of one or two well-equipped medical libraries and the advancement of laboratory and research work. All of the activities are to be carried on under the general supervision of a resident commissioner and an advisory committee.

It would be unfair to conclude this review without mentioning one fact that the report clearly indicates, viz., that an enormous amount of unselfish work has been performed under the most adverse and discouraging conditions by the western medical men and nurses now in the Chinese Empire. It is clear that there are practically no medical institutions in China where ideal conditions are to be met with. The lack of funds, the lack of physicians and nurses, the lack of proper buildings and equipment, the traditions of the people, all of them combine to make medical life in China anything but a bed of roses. But after all, these very deficiencies can not fail to appeal to the imagination of medical men and of nurses who are imbued with the desire for service coupled with the spirit of the pioneer. For to the pioneer, more than to all others, comes the joy of the struggle with the crude and the unfinished, and the satisfaction of leaving in its place a finished product stamped with the individuality of the worker.

GEORGE BLUMER

YALE UNIVERSITY

Die Lichtelektrizität. Von WILHELM HALLWACHS. Akademische Verlagsgesellshaft Leipzig, Germany. Mit 19 Figuren in Text. Pp. xi + 1–343.

This is, in all respects, the most compendious and complete treatise on photo-electricity which has yet appeared. Being written by one who is credited by Hertz himself with the discovery

of the real nature of the effect of ultra-violet light in facilitating discharge, and in honor of whom the phenomena of photo-electricity are not infrequently called "The Hallwachs Effect," one too whose laboratory has been perhaps the most continuous and prolific contributor to the literature on the subject, this book gains an authoritativeness which none of its predecessors can claim.

In addition, the book has been written with an admirable objectiveness and freedom from bias of either a national or personal kind. All experimental work is reported fairly and fully, and all theories are presented from the points of view of their authors. Professor Hallwachs does not hesitate to state his own convictions, but he never seeks to impose them. If only the scholars and statesmen had carried over into political affairs the method and spirit which Hallwachs here exemplifies, there would have been no great war.

Professor Hallwachs divides his historical survey of photo-electricity into two periods: the first period extends from the discovery of the photo-electric effect in 1887 to the year 1900; the second period covers the period from 1900 up to the present. This division is probably due to the fact that the interpretation of all electrical phenomena from the standpoint of the electron theory began about 1900.

The first two hundred pages constitute an exceedingly valuable digest of all the experimental work done up to August, 1913. In the 11th Chapter, too, this summary is extended so as to include all articles which appeared up to the end of the year 1913. Some of the most interesting photo-electric developments which have appeared since 1913, especially those having to do with the relations of Planck's h to the initial energy of emission and the relation of gases to photo-electric discharge, could not be included at the date at which the book went to press.

The portions of the book thus far considered make it an invaluable reference book to every student of photo-electricity. But it is in the thirty-five pages included in Chapter 9 that the greatest interest in the book will center, for it is in this chapter, which is entitled "Ueber den lichtelektrischen Grundprocess; Versuche einer speziellen Deutung der Lichtelektrischen Vorgänge," that the author reviews and weighs all attempts which have been made thus far at an interpretation of photo-electric results. He does not commit himself to a belief in any theory thus far formulated. He gives, however, a very clear exposition of the strength and weaknesses of the theories which are at present before the scientific world.

R. A. Millikan
University of Chicago

Sewage Purification and Disposal. By G. Bertram Kershaw. London, Cambridge University Press, 1915. Pp. x + 340, 56 figures.

Although books on sewage purification and disposal are becoming increasingly numerous this new work of Mr. Kershaw's is a welcome addition to the list. The author was engineer to the Royal Commission on Sewage Disposal for many years and has a well-deserved reputation not only in England, but in this country. No one has had a better opportunity than he has had to study the various methods of sewage treatment under English conditions.

The present volume is a recapitulation of some of the previous works of the author and is published as one of the Cambridge Public Health series. It deals chiefly with the methods which have shown their value by experience and does not pretend to cover some of the newer processes which are now in the experimental state. For this reason it is a more satisfactory book to place in the hands of students than are those which do not take pains to discriminate between the old and the new, the tried and the untried. Throughout the book there is frequent reference to the cost of processes. The data are valuable, but American readers must remember that the conditions in England are different from those in the United States, and in general it will be necessary to nearly double the English prices in order to make them applicable to conditions in America.

The author omits entirely the subject of disposal of sewage by dilution as that subject

is to be dealt with in a forthcoming volume in the Cambridge Public Health Series by Dr. W. E. Adeney. This also will be welcomed by American readers. Another omission is that of the process so largely and successfully used in New England, the process of intermittent sand-filtration.

The author's treatment of septic tanks and their limitations is extremely interesting. He describes not only the hydrolytic tank by Dr. Travis and the Imhoff tank, but also the Kremer and Fieldhouse tanks, which are not as well known in this country. Greater attention is given to the disposal of sludge than in many books and the subject of trade wastes and their disposal is also treated at considerable length.

G. C. WHIPPLE

HARVARD UNIVERSITY

PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES

(NUMBER 5)

THE fifth number of volume 1 of the *Proceedings of the National Academy of Sciences* contains the following articles:

1. *Some Problems in Stellar Photometry:* JOEL STEBBINS, Astronomical Observatory, University of Illinois.

This was a part of the address of Mr. Stebbins as Draper Medallist before the Academy on April 20, 1915. It contains a number of suggestions as to probably fruitful methods and problems of stellar research with the aid of the photometer.

2. *The Composition of Brachiopod Shells:* F. W. CLARKE and W. C. WHEELER, United States Geological Survey, Washington.

The authors present an investigation to determine, more definitely than hitherto, just what substances are contributed by each group of marine invertebrates to the marine sediments, with a special reference to the formation of magnesian and phosphatic limestone.

3. *On the Occurrence of the Line 4,686A and the Related Series of Lines in the Spectra of the Planetary Nebulæ:* W. H. WRIGHT, Lick Observatory, University of California.

The line 4,686A and related series of lines as observed in the spectra of heavenly bodies, and more recently obtained from laboratory sources, have played an important rôle in some theories of the constitution of atoms; and Mr. Wright here presents a number of observations concerning the different forms in which line 4,686 occurs in nebulæ. In particular, he observes that it appears either as a narrow line in the nebulosity or as a broad band in the nucleus; rarely in both forms.

4. *The Nature of Nerve Conduction in Cassiopea:* A. G. MAYER, Department of Marine Biology, Carnegie Institution of Washington.

The nature of nerve conduction appears to be some chemical reaction involving the adsorbed sodium, calcium and potassium cations, and its rate is proportional to the concentration of these absorbed ions, and is thus a surface effect. The work, therefore, supports other recent work by Tashiro and Lillie.

5. *A New Canonical Form of the Elliptic Integral:* B. I. MILLER, Department of Mathematics, Johns Hopkins University.

A new canonical form of the elliptic integral is suggested which has the advantages over the Klein-Bianchi form that it is simpler in form, unique and invariant under certain transformations.

6. *The Structure of Complex Atoms and the Changes of Mass and Weight involved in their Formation:* W. D. HARKINS and E. D. WILSON, Kent Chemical Laboratory, University of Chicago.

This is a contribution to a subject at present very widely discussed as to the nature of the atom. The authors find that it is possible to construct the various atoms of low atomic weight out of the helium and hydrogen atoms. The departure of the atomic weights from integral values on the hydrogen basis is attributed to the fact that the interference of the electric charges in the nucleus of the helium atom produces a diminution of the electromagnetic mass sufficient to lower the atomic weight; and close coincidence of the atomic weights with integral values on the oxygen basis is taken to indicate that the diminution

of mass occurs mostly in the formation of the helium atom and scarcely at all in the combination of helium and hydrogen atoms into the atoms of higher atomic weight.

7. *Huntington's Chorea in Relation to Heredity and Eugenics:* C. B. Davenport, Station for Experimental Evolution, Carnegie Institution of Washington.

Nearly 1,000 cases of Huntington's chorea are traced back to some half dozen individuals. The choreic movements never skip a generation and in other respects show themselves clearly to be a dominant trait; nevertheless, there is no clear evidence that persons belonging to the choreic lines voluntarily abstain from marriage, or are selected against in marriage.

8. *The Alcyonaria as a Factor in Reef Limestone Formation:* L. R. Cary, Department of Biology, Princeton University.

To determine the amount of material contributed to reef formation by the gorgonians three factors are taken into consideration: first, the amount of lime held as spicules in the tissues of these colonies; second, the bulk of the gorgonians present on any reef area; and third, the number of colonies which will set free their spicules through the death and subsequent disintegration of their cœnenchyma.

9. *Transformations of Conjugate Systems with Equal Invariants:* L. P. Eisenhart, Department of Mathematics, Princeton University.

The author has previously described what he has called "transformation K" and "transformations Ω"; and in this note he shows that there is a fundamental relation connecting those transformations.

10. *On the Pole Effect in the Iron Arc:* C. E. St. John and H. D. Babcock, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

In a continuation of their communication in the March number of the *Proceedings*, the authors find that it is necessary to consider the pole effect in the determination of wavelengths in international units. The wavelengths are not affected by wide variations of density of the radiating vapor and appear to be independent of changes in temperature. The pole effect does not occur in vacuo and appears independent of electrical conditions.

11. *Inheritance in the Asexual Reproduction of Hydra Viridis:* K. S. Lashley, Zoological Laboratory, Johns Hopkins University.

This investigation aims to contribute to the answer of the questions: Do heritable variations commonly occur among the offspring of a single individual multiplying asexually? and may selection among such offspring produce strains differing in hereditary characters? He finds that the only effect of selection is a temporary change in the vigor of the selected polyps and that there is no cumulative inheritance of variations in the number of tentacles within the clone. There is some evidence that the same conclusions apply to the inheritance of size.

12. *On the Monticellite-like Mineral in Meteorites and on Oldhamite as a Meteoric Constituent:* G. P. Merrill, Department of Geology, United States National Museum, Washington.

The author has subjected to microchemical analysis and to optical study the colorless mineral whose presence in chondritic meteorites has been observed by several previous investigators. He presents sectional drawings showing the appearance and optical properties of the mineral, which appears to be a form of calcium phosphate. He also calls attention to the presence of oldhamite (calcium sulphide) in meteorites from various sources.

13. *Absolute Scales of Photographic and Photovisual Magnitude:* F. H. Seares, Mount Wilson Solar Observatory, Carnegie Institution of Washington.

Mr. Seares describes the arrangement at the Mount Wilson Observatory for determinating absolute scales of photographic and photovisual magnitudes extending over about 17½ magnitudes for the photographic scale and about 15½ for the photovisual scale. The various difficulties which are met in comparing stars so different in brightness as is implied in these ranges of magnitudes are discussed,

and the details of the method employed are indicated.

14. *Mitosis in Trichomonas:* C. A. KOFOID and O. SWEZY, Zoological Laboratory, University of California.

The authors conclude that cell-division in trichomonad flagellates is a true mitosis with differentiated chromosomes, which split longitudinally prior to their location in the equatorial plate; that the nuclear membrane persists throughout mitosis; that the paradesmose between the migrating blepharoplasts is extranuclear at all times, disappears after nuclear division, and does not give rise to the axostyle; and that the axostyle splits longitudinally and thus forms two daughter axostyles.

The number concludes with the report of the annual meeting (which has already appeared in SCIENCE) by the home secretary, and with announcements of the research grants made from the trust funds of the academy during the preceding year.

SPECIAL ARTICLES

THE CONTINUOUS SPECTRA OF GASES

IN spectroscopic literature there are many casual references to a continuous background in the vacuum-tube spectra of various gases, such as oxygen, chlorine, etc. Usually these observations appear to have been confined to the visible region, and I can recall no comments on continuous spectra in the ultra-violet except in the case of hydrogen. Schniederjost[1] and Friederichs[2] observed such a spectrum at low pressures, which extended to a wave-length of about 2,100. The latter attempted to use the uncondensed discharge through a small capillary tube at about 2 mm. pressure as a source for the photography of absorption spectra, but found that the results were unsatisfactory, even with exposures varying from twelve to twenty-four hours.

In photographs of the hydrogen spectrum obtained with a large two-prism quartz spectrograph I have frequently observed this continuous spectrum. Although the resolving power of this spectrograph in the extreme ultra-violet is greater than that of a five-inch grating in the first order, there is no evidence of resolution into lines or bands. The spectrum appears to be uniformly continuous, and it seems likely that its gradual fading out in approaching the wave-length 2,100 is due rather to the absorption of the thick quartz system than to the lack of these wave-lengths in the emitted light. It appears to be due to pure hydrogen, for successive improvements in purity due to the removal of oxygen, water vapor, and nitrogen cause no noticeable change; nor does the addition of a trace of oxygen to hydrogen previously freed from that gas as far as possible cause any appreciable difference.

It seems very unlikely that a continuous spectrum can arise from free vibrations within the atom or molecule, hence it has been usually ascribed to molecular collisions. In comparing different gases at the same pressure, the number of collisions would depend mostly on the mean velocity of the molecules, so that the number of collisions would rapidly diminish as the molecular weight increases; hence we might expect that the continuous spectrum of a light gas would be stronger than that of a heavier gas. This was found to hold good for hydrogen, helium and neon. Photographs were obtained of the spectra of these three gases in vacuum tubes prepared by Hilger. The pressure was about the same in all. With a two-minute exposure, the continuous spectrum of hydrogen was very intense; that of helium about half as strong, and that of neon about one third as strong. They all extended to about the same limit—that set by the transparency of the quartz. In all these cases the uncondensed discharge of a medium-sized induction coil was used. The introduction of a condenser almost completely obliterated the continuous spectrum. When a condenser is used the radiation probably comes from dissociated ions, with free periods little disturbed by molecular collisions.

Nitrogen, krypton and xenon did not show any continuous spectrum.

Some tests showed that hydrogen tubes may render excellent service as sources for the

[1] Schniederjost, *Zt. f. Wiss. Phot.*, p. 265, 1904.

[2] Friederichs, Bonn Diss., 1905.

study of absorption spectra in the ultra-violet. It was not found advisable to use capillary tubes, nor to work at such low pressures as Friederichs did. The best results were obtained with end-on tubes, from 5 to 10 mm. in diameter and about 30 cm. long, with quartz windows, and at pressures in the neighborhood of 5 mm. The necessary exposure varies from 5 minutes to an hour, according to the width of the slit, the absorptive power of the medium, etc. I have obtained a beautiful photograph of the absorption spectrum of benzol vapor with fifteen minutes' exposure.

E. P. Lewis

University of California,
May 18, 1915

THE IOWA ACADEMY OF SCIENCE

The twenty-ninth annual session of the Iowa Academy of Science was held in the Hall of Physics, State University of Iowa, Iowa City, on April 30 and May 1, 1915. Over one hundred members were registered. At the opening session on Friday afternoon, after the transaction of preliminary business, the president, Professor H. S. Conard, called for the presentation of papers of general interest. At 4 P.M. the academy separated into sections for the further reading of papers as follows: section one, botany; section two, physics, chemistry and mathematics; section three, zoology, geology, psychology, medicine.

Professor Ellery W. Davis, of the department of mathematics in the University of Nebraska, gave the annual address on the subject "Uncertainties," a discussion of the foundations of exact knowledge.

On Saturday morning the sections resumed their meetings, except that the Iowa section of the American Chemical Society met independently. At the business meeting the following officers were elected for the coming year.

President: Harry M. Kelly, Mount Vernon.

First Vice-president: G. W. Stewart, Iowa City.

Second Vice-president: Charles R. Keyes, Des Moines.

Secretary: James H. Lees, Des Moines.

Treasurer: A. O. Thomas, Iowa City.

The sectional meetings were so successful that a continuation of the plan was decided upon for the next annual meeting.

Luncheons were enjoyed on Friday evening by the geologists and geographers as guests of Dr. and Mrs. Kay, by the mathematicians and by the physicists. A general luncheon was participated in by the members of the academy on Saturday noon, following the business session.

Program

(Abstracts are by the authors.)

Preliminary Notes on Nectar Production: L. A. Kenoyer.

An Anomalous Hickory-nut; An Exobasidium on Armillaria; The Rôle of Soil Fungi: Guy West Wilson.

The Forest and Shrub Flora of Western Iowa: L. H. Pammel, G. B. MacDonald and H. B. Clark.

This paper discussed the distribution of trees and shrubs of the drainage basin of the Missouri River and some of its tributaries. A number of southern species like *Cercis canadensis* and *Asimina triloba, Quercus acuminata* and *Vitis cinerea* reach their northern distribution in Fremont County.

The Weed Flora of the Lake Superior Region Compared with the Weed Flora of Iowa: L. H. Pammel.

A brief comparative study of the distribution of weeds of the northern lake region and the prairie region of Iowa.

Some Comparative Germination Tests of Sweet Clover: H. S. Doty.

A test of the germination of sweet clover treated with sulphuric acid, scratching, freezing and the Hughes method. It was found that scarification, freezing and the acid hastened the germination of seeds.

The Flora of the Ledges, Boone County, Iowa: Wm. Diehl, presented by L. H. Pammel.

A systematic catalogue of the spermatophytes and ferns of the ledges comprising a small area of Carboniferous sandstone along Pease Creek, a small stream which empties into the Des Moines. In this region occur a number of species of local range like *Quercus acuminata, Dirca palustris, Juniperus virginiana, Physocarpus opulifolius, Lathyrus ochroleucus, Trillium nivale,* etc.

Flora of the East Slope of the Cascade Mountains in Crook County, Oregon: Morton E. Peck.

The paper discusses briefly the general distribution of the flora on a line drawn across the Cascade Mountains in central Oregon, then takes up more in detail the plants occurring on the lower portion of the eastern slope, namely, at the town of Sisters. A study of these indicates that the locality is

typically arid transition. There follows an annotated list of plants recorded by the writer on a trip across the arid transition in this section of the state in July, 1914.

Flora of the Racing River Region: HARRIETTE S. KELLOGG.

In August, 1914, the writer collected plants along the south bank of the Rainy River near the "Old Dock" in the city of International Falls, Minnesota.

The territory explored consisted of a timber belt lying back from the river and cleared ground still back of this.

The timbered belt consisted largely of birches, poplars, maples and other deciduous trees interspersed with cedars and spruces and species of an arborescent nature. Underneath was the characteristic forest herb flora; the cleared ground was covered with introduced plants of a weedy character; there was an almost entire absence of strand flora. East of the dock was a luxuriant growth of tame grasses and clovers, the seed of which had been scattered when grain was carried to the dock for transportation by boat.

A few species are listed that were collected from the Canadian bank of the river, several from the Rainy Lake region and a few from the west bank of the Winnipeg River.

Economic Seaweeds of Alaska (illustrated): ROBERT B. WYLIE.

A brief statement of the findings of the U. S. Kelp Expedition which made a survey of the potash-yielding seaweeds of southeastern Alaska during the summer of 1913.

A Hybrid Ragweed (illustrated): ROBERT B. WYLIE.

The description of a hybrid, probably a cross between *Ambrosia artemisiifolia* and *A. trifida*, found near Iowa City during the summer of 1914.

The Distribution of Forest and Prairie in the Lake Region of Iowa (with lantern slides): B. SHIMEK.

The Okoboji region is discussed. The groves appear uniformly on, or in the shelter of abrupt slopes or in rough areas consisting of a group of ridges or knobs. They are found on the leeward side of abrupt slopes anywhere about the lakes; but they occur on the windward side only on the east and north sides of the larger lakes. In the latter case the establishment of a forest seems to be made possible by the piling up of vapors under the banks on the windward side.

The Lichen Flora of the Prairies of Northwestern Iowa: B. SHIMEK.

This consists largely of xerophytic species attached to boulders. Few earth forms occur. The rock forms are most abundant on dry knolls and in exposed places. A comparison of this flora is made with that of the xerophytic borders of prairie burr oak groves. An annotated list of the species is included.

The Ecological Histology of Certain Prairie Plants: ELLA SHIMEK.

The paper discusses the xerophytic adaptation of certain species of prairie plants in detail.

Pioneer Plants on a New Levee: FRANK E. A. THONE.

A description of the plants appearing on a newly exposed surface in Des Moines, Iowa, during the first season after exposure, with remarks concerning their possible origin.

The Index of Foliar Transforming Power as an Indicator of Permanent Wilting of Plants: A. L. BAKKE.

Some Well-known Building Stones: NICHOLAS KNIGHT.

An analysis was made of the Anston Stone, from Kiveton Park, England, the material of which the Houses of Parliament are built, to learn, if possible, the cause of the crumbling of the rock. It proved to be a dolomite, of a light buff color, with a specific gravity of 2.6.

The red sandstone from the Vosges Mountains, of which many public and private buildings in Alsace-Lorraine, including the Strassburg Cathedral, are constructed, was studied. The rock is a hard, durable building material and lends itself to delicate carvings, as shown by the fine Gothic of the tower and façade of the cathedral.

The "Hard Jewish," a compact rock from Solomon's quarries, Jerusalem, with a specific gravity of 2.7, also was analyzed.

A New Apparatus for Regulating Temperatures for Work in Polarimetry and Refractivity; Electrical Conductivity of Solutions of Silver Nitrate in Water and Pyridine and in their Binary Mixtures (preliminary paper): J. N. PEARCE.

A Convenient Standard Cell—(Cu—Hg)—$CuSO_4$—Hg_2SO_4—Hg: DIEU UNG HUONG AND J. N. PEARCE.

Some Derivatives of 4-nitro-5-methyl-2-sulphobenzoic Acid: WM. J. KARSLAKE AND P. A. BOND.

Comparison of Some Standards in Acidimetry and Alkalimetry: W. S. HENDRIXSON.

Studies on Barium Sulfate: P. L. Bluementhal and S. C. Gurnsey.

A Comparison of Some Kjeldahl Methods for Nitrogen Determination: P. L. Bluementhal and G. P. Plaisance.

The Ste. Genevieve Formation and Its Stratigraphic Relations in Southeastern Iowa: Stuart Weller and Francis M. Van Tuyl.

Recent field studies have shown that the Pella limestone, which was formerly regarded as the uppermost subdivision of the St. Louis, is formationally distinct, being separated from the true St. Louis beneath by an unconformity and a remarkable basal sandstone. The previous reference of this member to the Ste. Genevieve upon the basis of its fauna is, therefore, borne out by the field evidence.

The Occurrence and Origin of the Iron Ores of Iron Hill, Near Waukon, Iowa: Jesse V. Howell. Introduced by G. F. Kay.

The Extension of the Wisconsin Drift Southwest from Des Moines: John L. Tilton.

This newly recognized area of Wisconsin drift extends from Valley Junction just west of Des Moines for five miles to the south. In all directions, east, south and west, from this strip, now only about a mile wide, the topography is that of a typical area of Kansan drift.

The Age of the Terrace South of Des Moines, Iowa: John L. Tilton.

A low terrace is very noticeable near Des Moines and along streams flowing into the Des Moines from Warren County. The topographic maps give evidence of a similarly related terrace further southeast and then north along the Mississippi River to within the area of Wisconsin drift in that part of the state. The terrace is composed of sand and gravel forming a continuous deposit to a depth of thirty feet, post-Wisconsin in relation, and with Wisconsin or post-Wisconsin fossils: Bison, Rangifer, Symbos.

The First Coal-washing Plant in Iowa; The Mineral Industry in Iowa During the Past Decade: George F. Kay.

The Occurrence of Barite in the Lead and Zinc Districts of Iowa, Illinois and Wisconsin: W. D. Shipton.

Precise Criteria of Terranal Correlation: Charles Keyes.

The signal failure of our state and federal geological surveys to give us working classifications of local geologic formations that are readily adjustable to the general continental scheme has recently led to the adoption by the various bureaus of somewhat arbitrary methods in order to make published records immediately available. In casting about for a suitable area for which to construct a generalized section of local rocks the quadrangle, as ordinarily selected, appears to be much too small to be of any real service. The county is likewise too limited in extent. In size the state seems to be most satisfactory for trial tests in continental problems of exact correlation. A number of these generalized state sections reduced to identical taxonomic schemes are compared.

Mountain Structures in Plains: Charles Keyes.

The larger tectonic features of the substructure of the prairie region of the continental interior are of unusual interest because of the fact that well-defined mountain structures are now discovered here for the first time. A carefully constructed geologic cross-section extending from the northwest corner of Iowa to the southeast corner of Missouri presents one of the most perfect synclinoria known. Within this remarkable basin are preserved our great coal deposits.

At the north end of this synclinorium is the structural remnant of old Triassic mountains, a range which in its prime was comparable to the Appalachians of to-day. At the south end is the Ozark dome of Tertiary date. Associated with the great trough is a noteworthy system of profound dislocations.

Exhumed Sea-coasts: Charles Keyes.

A curious geologic coincidence occurs on the shores of Puget Sound. There has been in this region during late geological times more or less oscillation of the land. In a previous cycle the hard igneous rocks were carved out by the waves into low, irregular sea-cliffs. On the sinking of the islands sands and gravels covered this belt to considerable depths. To-day, with a marked uprising, the new shore-line is contraposed on the ancient one. In a quite remarkable way the latter is being now exhumed by the action of the waves.

Progress Report of Physiographic Work in the Driftless Area: A. C. Trowbridge.

The Paleontology and Stratigraphy of the Upper Carboniferous of Iowa: George L. Smith.

The Loess of Peczel, Hungary (with lantern slides): B. Shimek.

A discussion of true loess and an underlying water deposit which has been classed as loess. The true loess contains a strictly terrestrial molluscan

fauna, and in some places is divisible into a lower gray, and an upper yellow division, not unlike those which are common in this country.

The fauna of the lower, horizontally stratified deposit is mixed, consisting of both land and fresh water mollusks. This part is not loess, and is clearly aqueous.

Leaching of the Pleistocene Drifts of Eastern Iowa: MORRIS M. LEIGHTON.

This paper is a discussion of the process of leaching of the calcareous constituents of the drift in the area above stated. Attention is called to the fact of a narrow transition from the leached zone into the calcareous where limestone pebbles reach their normal abundance, and the contention is set forth that this may be a factor of slow percolation and rapid saturation. The contention is also set forth that the bottom of the zone of leaching in the young drifts may not mark the so-called permanent ground-water surface, as is commonly assumed, but that it may well be above the latter.

Some Unique Niagaran Cephalopods; A New Crinoid Fauna from Monticello, Iowa; High Level Gravels in Floyd County, Iowa: A. O. THOMAS.

The Inheritance of Syndactylism: HENRY ALBERT.

An instance of thirteen cases of syndactylism (or fused or webbed fingers or toes), traced through four generations was reported. The element of heredity is obviously apparent. In view of the recent report of a family with cases of syndactylism in which the inheritance of the abnormal union of the digits apparently conformed to Mendel's law, as a dominant character, an effort was made to determine if the Mendelian law also applied to the cases in question. It was determined that although the disease was due to a factor which was apparently dominant rather than recessive, it did not conform entirely to Mendel's law. That it is not due to a Mendelian recessive character is shown by the fact that in three instances the disease appeared in children, neither of whose parents were affected by it, and in each instance the family history of at least one of the parents was negative for the disease in question. To have a disease due to a recessive character appear in an individual, neither of whose parents are affected by it, we must assume that both parents are hybrids as regards the condition in question.

Nor does it entirely conform to a Mendelian dominant character, since if it did we would expect that if the disease appeared in the offspring it should be present in at least one of the parents.

It is probable that the explanation for the lack of conformity of our cases to Mendel's law is due to an inhibition of the activity of the determiner for the disease in question by some other factor, causing the disease in such cases to be latent. The absence or non-operation of such inhibiting factor may again cause the disease to appear.

The Effect of Alcohol on the Liver as Shown Experimentally: A. L. GROVER. Introduced by HENRY ALBERT.

The Effect of Change of Lamp Voltage on Vision: WM. KUNERTH.

This paper is an experimental determination of the change of lamp voltage permissible before it is noticed, as also of the change permissible before it really becomes objectionable to the patron. The permissible change of voltage for the different sizes of carbon lamps is determined, as also the permissible change for vacuum tungstens and nitrogen-filled tungstens.

A Simple Device for Demonstrating the Tempered Scale: L. B. SPINNEY.

An Attempt to Detect a Change in the Heat Conductivity of Selenium Crystals Under the Influence of Light: L. P. SIEG.

Notes on Certain Elastic Peculiarities of Phosphor Bronze Wires: L. P. SIEG AND A. J. OEHLER.

On the Wave-length-sensibility Curves of Isolated Crystals of Selenium Between Wave Lengths 2000 Å. U. and 4500 Å. U.: F. C. BROWN AND L. P. SIEG.

A Design for Electrical Regulation of High-temperature Ovens; Notes on Production, and Some Electrical Properties of Tellurium Crystals: W. E. TISDALE.

A Resonance Method for Measuring the Phase Difference of Condensers: H. L. DODGE.

The Theory of Binaural Beats.—An Experimental Contribution: G. W. STEWART AND HAROLD STILES.

The experiments here reported were performed in order to secure evidence concerning the cause of the additional maxima which occur in binaural beats.[1] These additional maxima occur at certain phase differences, and the change in these phase differences should depend upon the frequency of the tones, but not upon the frequency of the beats. If the additional maxima are caused by interaural conduction then, as it can be shown, the phase differences should vary as the frequencies. If the data are plotted, instead of the straight line which

[1] See G. W. Stewart, *Physical Review*, Series 2, 3, p. 146, 1914, for a description of the phenomena.

should obtain in the case of interaural conduction, we have a curve which is far from a straight line.

After much consideration of theories involving interaural conduction, none seems to be in agreement with the evidence here shown.

The Absence of Liberation or Absorption of Electrons During a Change from the Conducting to the Non-conducting State: L. E. Dodd.

Crystals of metallic selenium were melted in a metallic cup attached to a sensitive electroscope. The heating agent was a focus of sun's rays supplied by a convex lens; this method of applying heat was used in preference to flames, which possess high ionizing powers. Previous to the change of state of the selenium the electroscope was given a negative charge. During the time required for the change of state a certain deflection of the electroscope leaf was observed. With the crystals removed from the cup, and the sun's rays focused at the same point as before, two comparison readings were made over time intervals equal to that required for the change of state. Changes of deflection resulted of similar magnitude to that first observed.

The experimental conclusion is that in metallic selenium, when it changes by melting from the crystalline and conducting form to the amorphous and insulating form, electrons are neither absorbed from, nor liberated to, the surrounding medium, in any very appreciable amount.

The Crystal Optiphone in its Adaptation to Enable the Blind to Read the Printed Page through Ear Impressions: F. C. Brown.

The Variation, with Temperature, of the Light-sensitiveness of Selenium Crystals: Kathryn J. Dieterich.

The Wave-length Sensibility Curves of Selenium Blocks: E. O. Dieterich.

Psychology Applied to the Improvement of Control of the Pitch of the Voice in Singing: Carl J. Knock. Introduced by C. E. Seashore.

Psychology Applied to Measurement of Merit in Advertisements: Harry H. Gould. Introduced by C. E. Seashore.

The Psychogram in Vocational Guidance: C. E. Seashore.

A Bacteriological Study of the Wells of Toledo, Iowa: W. H. Lauderdale and L. A. Kenoyer.

Preliminary Notes on the Animal Ecology of Johnson County: D. M. Brumfiel. Introduced by Gilbert L. Houser.

This paper is based on an early spring survey of the forms of animal life found in a small stream. The rapids and pools are discussed with a division of the species into particular animal associations. The species have been catalogued with brief notes as to habits and a table has been prepared giving in concrete form the distribution, food habits and relative abundance of each species.

On the Lymphatic System of the Common Rat (Epimyus norvegicus): Thesle T. Job.

From fifty injected specimens, the gross anatomy of the common rat has been studied and outlined. The results of the work have further proven the studies of McClure and Silvester on the lymphatico-venous communications in the jugulo-subclavian district, and of Silvester on the renal vein communications, and have established two additional communications, the portal vein connection and the ilio-lumbar vein connection. The main circulation and disposition of the lymphatic system has been determined and the need of further knowledge concerning the histology of the lymph nodes, of which there appear to be two types, is pointed out.

Notes on the Development of the Lymphatic System of Turtles: Frank A. Stromsten.

The Present Status of the Hessian Fly in Iowa: R. L. Webster.

Tracheal Capillaries of the Grasshopper: L. S. Ross.

The Inheritance of Fertility in Swine: Edward N. Wentworth.

Is the Appetite of Swine a Reliable Indication of Physiological Needs? John M. Evvard.

Notes on Iowa Pentatomoidea: Dayton Stoner.

The Crow: Fred Berninghausen.

On Snakes "Swallowing" Their Young: E. D. Ball.

A common garter snake was frequently seen to "swallow" her young. The little snakes would often push their heads out of the mother's mouth and thrust out their little tongues.

The Building and Function of the College Museum: B. H. Bailey.

Notes on the Distribution of the Prairie Spotted Skunk in Iowa: B. H. Bailey.

Ictinia Mississippiensis in Nebraska: B. H. Bailey.

Published in full in the *Wilson Bulletin* of Oberlin College.

James H. Lees,
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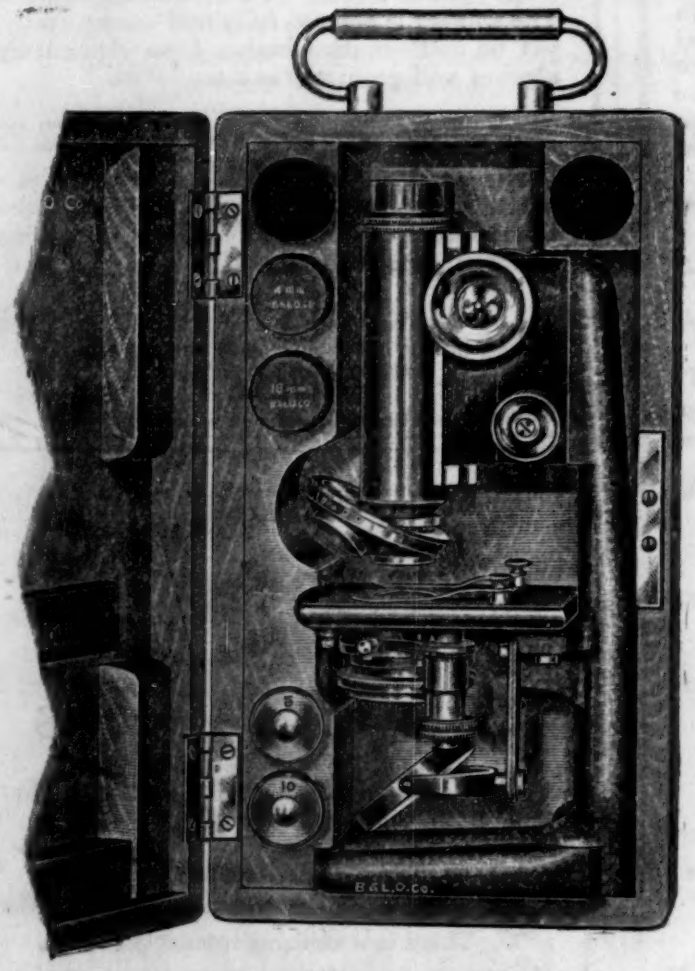

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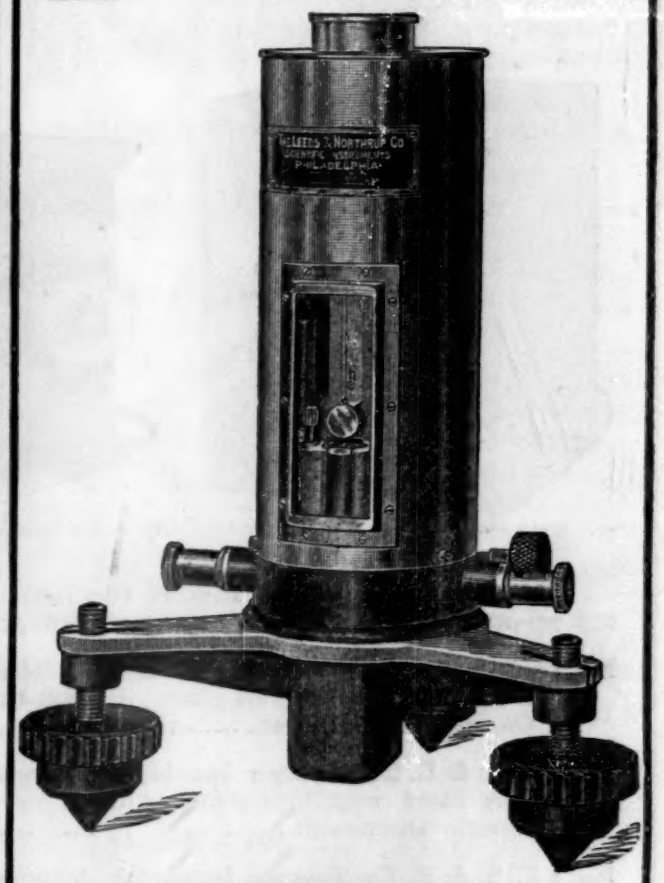

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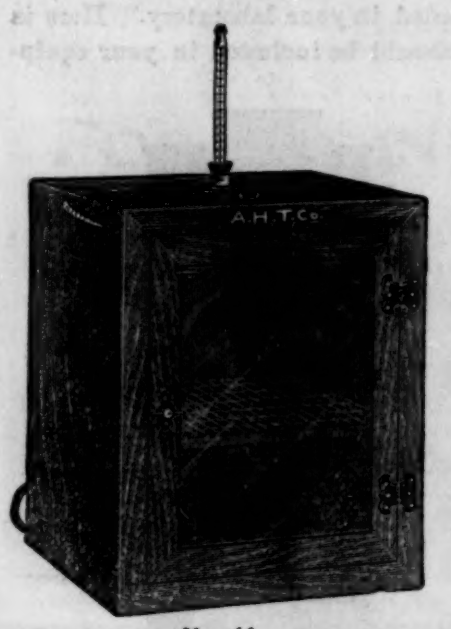

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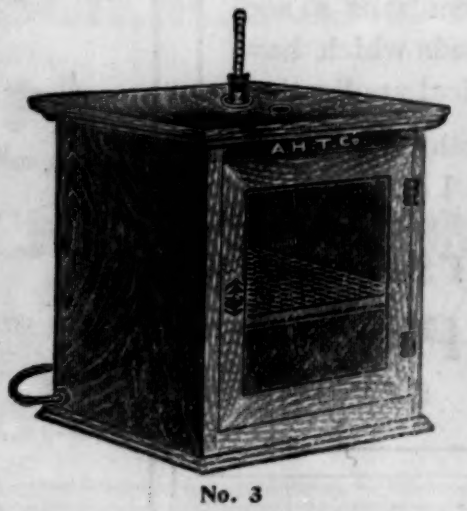

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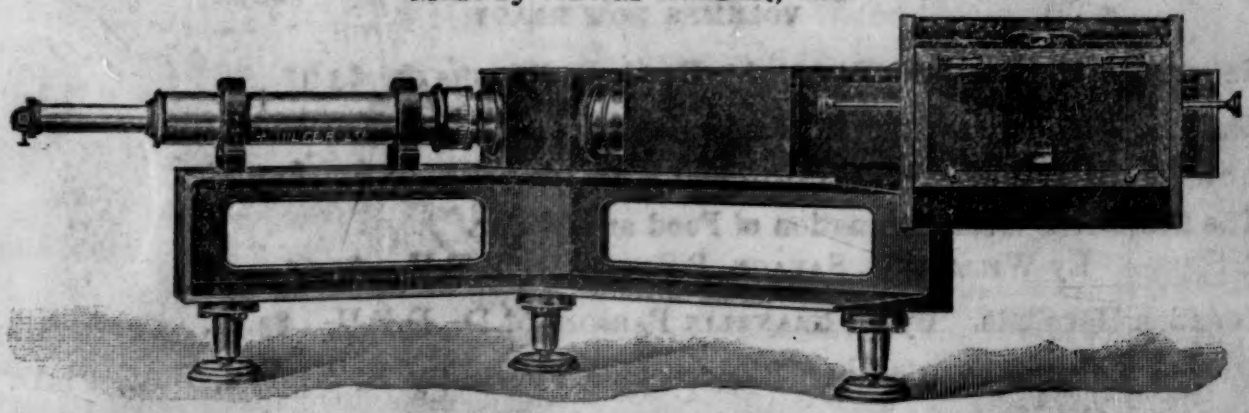

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